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THE
CANADIAN JOURNAL
OF
INDUSTRY, SCIENCE, AND ART:

CONDUCTED BY THE

EDITING COMMITTEE OF THE CANADIAN INSTITUTE.

NEW SERIES.

VOL. VIII.

Smithsonian Institution
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U.S. National Museum

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BY LOVELL AND GIBSON, YONGE STREET.

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⁂ *Communications to be addressed to the General Editor,*
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THE CANADIAN JOURNAL.

NEW SERIES.

No. XLIII.—FEBRUARY, 1863.

DESCRIPTIONS OF SOME SPECIES OF NOCTURNAL LEPIDOPTERA, FOUND IN CANADA.

BY THE REV. CHARLES J. S. BETHUNE, M. A.
COR. MEMB. ENT. SOC. PHILADA., AND SOC. OF NAT. SCI., BUFFALO.

The following descriptions of Canadian Moths have been prepared with a view to second the efforts now being made by Professor Hincks for the accumulation of materials for a "Fauna Canadensis." In the September number of the *Journal*, he directed attention to the want of information respecting almost every department of Natural History in this country, and expressed his desire that some attempt should be made both to facilitate present investigations, and to render whatever is already known available for the production hereafter of a general work on Canadian Zoology. In the department of Entomology, one of the chief difficulties in the way of its successful pursuit,—that arising, namely, from the want of reliable books upon the subject,—has lately been lessened to a considerable extent. The Smithsonian Institution, in carrying out its great design of "increasing and diffusing knowledge among men," has during the last five years, published several valuable works on Insects, for the especial purpose of facilitating the study of this branch of natural history. These works have been prepared by some of the best authorities on the orders of which they respectively treat, and are certainly the most useful of any on the ubject that have yet appeared on this Continent. The most recently published of them is a Synopsis of the described Lepidoptera of North America, by the Rev. Dr. Morris of Baltimore, containing the Rhopalocera, and the first two groups (Sphingina and Bombycina) of the Heterocera. This volume has conferred a great boon upon Entomologists in general, and especially upon those who are only beginners in the pursuit, inasmuch as it contains descriptions collected from upwards of fifty different works, many of them rare and expensive, and most of them not be met with in this country. As this Synopsis can so easily be obtained, it will be unnecessary to publish in the Journal any descriptions that have already appeared in it. Of the remaining groups, however,—at least of the Canadian species of them,—very little is known; it has occurred to me, therefore, that descriptions of, at all events, the common and more conspicuous ones would assist many in determining some of their specimens, and, at the same time, be a small contribution to Prof. Hinck's very commendable object—the formation of a "Fauna Canadensis."

NOCTUINA, *Staint.*

To this group belong the great majority of our night-flying moths, though some few genera are to be met with even in the full glare of noon-day. They may be recognized in their perfect state by the following characters:—

Body generally stout. Antennæ longer than the thorax, tapering from the base to the tip, filiform, ciliated, or pubescent, more or less bent or twisted, never terminating in a hook; those of the female nearly always simple. Palpi well developed, generally projecting beyond the head. Abdomen almost always extending beyond the hind wings. Legs of variable length, but generally long, especially the posterior pair, which are always longer than the preceding ones; hind tibiæ usually with four long spines. Wings moderately broad, rarely narrow or very broad, never elevated in repose, or rolled about the body; fore wings straight in front, rounded or angular at the tips, oblique on the exterior border; almost always marked with three, sometimes with four, transverse lines, and two spots: the hind wings are more or less folded, and generally covered by the fore wings when in repose.

A full explanation is given in Morris' Synopsis, alluded to above, of the neuration, ordinary markings, etc., of the wings, and the terms used in describing them; it need only be mentioned here therefore, to save the trouble of reference, that the transverse lines on the fore wings are thus distinguished:—That nearest the base, seldom reaching more than half across the wing, is called the *half line;* the next, before the middle of the wing, the *inner line;* then, beyond the middle, the *elbowed line*; and lastly, the *subterminal line.* Of the two spots, or stigmata, the one nearest the base of the wing, is round or oval, and is called the *orbicular spot;* the other is kidney shaped, and is called the *reniform spot;* beneath the former is sometimes a third, of a wedge-shape, called the *claviform* spot.

The Noctuina are divided by M. Guénés, into two main groups, *Trifidæ* and *Quadrifidæ.*

Of the TRIFIDÆ, the imago is generally of moderate size, sometimes small; palpi short, or of moderate length, with the third joint never long or spatulate; hind wings usually much folded under the fore wings, the inner margins of which often overlap each other in repose; median vein of the lower wing with *three branches.*

Of the QUADRIFIDÆ, the imago has generally broad, sometimes very large wings; palpi always long and ascending, with the third joint long and filiform, sometimes spatulate; hind wings but little folded; the inner margin of the fore wings seldom overlap in repose; median vein of the lower wing with *four branches.*

The TRIFIDÆ, to which belong by far the greater number of our Noctuelites, are subdivided into three sections:—

BOMBYCIFORMES.—Palpi short and stout; legs not long; fore wings rather thick; hind wings slender.

GENUINÆ.—Palpi stout and well-developed; legs robust; fore wings very thick; hind wings slender, generally of dull colors.

MINORES.—Of small size; body slender; legs long and slender; wings broad; fore wings not very thick, triangular; hind wings well developed, often with similar markings and colors to those on the fore wings.

The QUADRIFIDÆ are divided into eight sections, three of which—the *Sericeæ*, *Patulæ*, and *Pseudodeltoidæ*,—are not found in Canada, being confined almost entirely to tropical climates. It is only necessary, therefore, to mention the characteristics of the remaining sections.

VARIEGATÆ.—Size small or moderate. Palpi well developed; often thick. Fore wings angular or denticulate on the inner margin, or with metallic blotches; hind wings of one color, sometimes pale or yellow, with a dark border; the first inferior vein generally more slender than the others.

INTRUSÆ.—Size moderate or large. Abdomen more or less flattened; antennæ pubescent or crenulate. Fore wings large, clouded; hind wings of a different color from the fore wings, first inferior vein always rather slender, and remote from the others.

EXTENSÆ.—Size moderate. Palpi ascending, almost vertical; second joint curved, generally pilose; third joint linear. Antennæ of the male crenulate, with short bristles; of the female simple. Abdomen rather long, smooth, seldom crested. Wings thick, clouded, adorned with wavy lines; hind wings almost always of the same color as the fore wings.

LIMBATÆ.—Size large or moderate. Antennæ never pectinated. Wings broad, well developed; fore wings with flexuous lines; hind wings different from the fore wings, gaily colored with two distinct hues; the first inferior vein almost always equal to the others, and not remote from them.

SERPENTINÆ.—Size moderate or small. Abdomen smooth, not flattened. Third joint of the palpi moderately long, not spatulate. Wings thick, and rather broad.

Having now briefly enumerated the chief subdivisions of the group Noctuina, I shall proceed to the description of various genera and species, taking up the commoner and more easily identified forms first, without regard to any particular order.

The subsection LIMBATÆ, to which belong the largest and handsomest of our nocturnal moths, is only represented in this country by one genus, CATOCALA, of the family CATOCALIDÆ. Specimens of these insects are generally to be found in every cabinet, as from their large size, and gaily colored under-wings, they are very conspicuous, and do not easily escape the observation of the collector. Their favourite haunts are the trunks of apple and other trees, where they feed on the sap that exudes wherever branches have been cut off. Toward the end of August, and during September, the commoner species may be found hovering about such places, a little before sunset and sometimes even earlier in the day. In repose they form a flat gray triangle, completely concealing with their fore wings the brilliant colors of the lower ones, and often closely resembling the bark of the trees on which they rest.

Gen. CATOCALA. Ochs.

Size large. Body stout. Palpi thick, pilose obliquely ascending, moderately long; their third joint very distinct, short. Antennæ slender, pubescent in male, setaceous in female, more than half the length of the body. Thorax convex, thickly pilose. Abdomen crested, generally extending beyond the hind wings. Legs lon , stout, very pilose. Wings large, slightly denticulated. Fore wings almost invariably gray, clouded with black and white; slightly convex along the costa, angular at the tips, moderately oblique on the exterior margin; the markings constant in almost all our species are, first, a series of dark points set off with white, close to the exterior margin; then the submarginal line, which is seldom clearly defined; the two following lines, however, are usually very distinct, and distant from each other: the inner line being composed of lunules or irregular arcs, the elbowed of teeth more or less sharp; of the two spots, the reniform is the only one visible, though it also is frequently much obscured; a third immediately behind it, called the *subreniform,* is more commonly apparent, being clearer than the others, and edged with black. Hind wings denticulated, crimson or luteous, with a black band and a black border, rarely wholly black, or black with a white band.

SYNOPSIS OF CANADIAN SPECIES.

A. Hind wings black, with a white band, 1. *C. relicta.*
AA. Hind wings black without bands, 2. *C. vidua.*
AAA. Hind wings red, with a black band and a black border.
  B. Fore wings gray, with a whitish spot on the inner side of the reniform spot, and another behind it.
    C. Elbowed line with two very prominent teeth, 3. *C. parta.*
    CC. Elbowed line without prominent teeth, 4. *C. unijuga.*
  BB. Fore wings with the transverse lines very much denticulated; reniform spot testaceous.
    D. Fore wings with a white discal spot, 5. *C. amatrix.*
    DD. Fore wings with no white discal spot.
      E. Hind wings scarlet, 9. *C. Ultronia.*
      EE. Hind wings rosy, 6. *C. Concumbens.*
  BBB. Fore wings with a light colored patch at the apex; reniform and another discal spot testaceous or whitish.
    F. Elbowed line of fore wings with two very long teeth, 7. *C. uxor.*
    FF. Elbowed line with moderately long teeth, 8. *C. ilia.*

AAAA. Hind wings luteous, with a black band and a black border.
  G. Fore wings gray.
    H. Hind wings with the fascia not excavated. 10. *C. cerogama.*
    HH. Hind wings with the fascia excavated, 11. *C. antinympha.*
    HHH. Hind wings with the fascia contracted in the middle. 19. *C. neogama.*
  GG. Fore wings cinereous, 12. *C. polygama.*

1. Catocala relicta, Walk.—*Cat. Brit. Mus. Noct.* 1192.

Body black, speckled with white, pure white beneath; thorax black with a few white hairs, in front white with a black band; abdomen above black, whitish between the segments and at the apex. Fore wings, ground color white, with the usual transverse lines black, and a black fascia in the middle of the wing, interrupted by the subreniform spot, which is white edged with black; marginal lunules deep black. Hind wings deep black, with a regularly curved white band, and white ciliæ; anal angle truncate. Under side of both wings white, with a series of black spots on the exterior margin; fore wings with three black bands also, which are wide on the costa, gradually diminishing toward the inner margin; hind wings with a black band, a black border, and the discal lunule deep black. Length of the body 12-14 lines; alar expansion 32 lines.

Hab. Cobourg. Toronto (Dr. Morris.) Nova Scotia.

2. C. Vidua, Smith,—Walk. *C. B. M. Noct* 1200. Guên, *Noct.* III. 94.

Body cinereous, beneath whitish; thorax with black bands in front; abdomen thickly clothed with white hairs at the base beneath. Fore wings cinereous, slightly glaucescent in the middle; the usual transverse lines well defined, black, closely approaching each other near the inner margin; elbowed line with two long sharp teeth a little before the middle, the exterior one longer than the other; subterminal line whitish, irregular, and denticulated; submarginal spots black, bordered externally with white; reniform spot light brown in the middle, edged with black. Hind wings velvety black, with a few long cinereous hairs at the base; ciliæ white, slightly interrupted by the black prolongations of the nervures. Beneath, forewings deep black, cinereous at the apex, white at the base, with two white bands extending half way across the wing from the costa, exterior one narrow, slightly curved, interior one broad and short; hind wings also deep black, with the basal half of the wing white, a white crooked fascia across the middle of the wing, and the ciliæ white. Length of the body 13 lines; alar expansion 27 lines. This species bears a strong resemblance to *C. insolabilis,* Guén. Found in the United States.

Hab. Toronto (Dr. Morris). United States.

3. *C. parta.* Guén.—*Noct.* III. 84. Walk. *C. B. M. Noct.* 1193.

Blackish, speckled with white. Abdomen cinereous, with a brownish tinge in the females. Fore wings rather oblong, very much denticulated; the two median transverse lines black, margined with white, much denticulated; the elbowed line with two prominent teeth, from which a black streak proceeds to the apex; there is also another black streak at the base, and a third parallel to the inner margin, towards the anal angle; subterminal line white, zig-zag; a whitish band between it and the elbowed line; reniform spot whitish, speckled and bordered with black; subreniform spot large, round, whitish, touching the reniform, which has also a whitish discal blotch on its inner side; submarginal lunules black, Hind wings rather pale red; the black median band moderately broad, straight, almost regularly curved, slightly abbreviated; the black border rather broad, with two slight sinuses on the inner side, and hollowed at the apex by a whitish spot. Under side of the wings cinereous on the exterior margin, with six bands, alternately black and white; of the hind wings, the first half is white, the remainder red, with the black band and border of the upper side, and a blackish discal lunule. Length of the body 12 lines; alar expansion 32 lines.

Hab. Cobourg. Very common.

St. Martin's Falls, Albany River, Hudson's Bay, (Dr. Barnston). United States.

4. C. UNIJUGA. Walk.—*C. B. M. Noct.* 1194.

Cinereous, thickly speckled with black. Thorax with black bands in front. Abdomen cinereous, first few segments tufted, lighter beneath. Four wings with a slight blueish tinge; the two median transverse lines black margined with white, (in some specimens composed of two black lines with a white one between them): the elbowed serrate, without prominent teeth, crossing the wing in a direct line; the inner wavy and thick: reniform spot blackish, indistinct, with a whitish blotch adjoining it on the inner side; subreniform, white, speckled with brown; and behind it a third spot near the inner margin, deep black; submarginal line white, serrate, distinct: marginal lunules black, edged with white exteriorly. Hind wings deep red, with fuscous hairs at the base; the black band moderately broad, narrow towards the inner margin, which it does not reach, with a slight indentation on the outer side between the submedian and the fourth inferior nervules; the black border broad, slightly wavy on the inner side towards the anal angle, where it becomes very narrow; a narrow white apical streak; ciliæ white. Under side very similar to that of the preceding species (*C. parta*). Length of the body, 12-14 lines; alar expansion, 30-34 lines.

Hab. Cobourg. London, C. W. (Mr. Saunders). St. Martin's Falls, Albany River, Hudson's Bay (Dr. Barnston). United States.

5. C. AMATRIX, Hübn. Walk.—*C. B. M. Noct.* 1195. Guén. *Noct.* III. 86.

Brownish cinereous. Thorax with black bands in front, and dark lines on the tegula. Abdomen testaceous cinereous. Four wings almost rectangular at the apex, the denticulations much rounded; with a black shade proceeding from the middle of the base to the extremities of the first two superior nervules, on the exterior margin, interrupted in the middle by the subreniform spot, which is whitish marked with testaceous; reniform spot dark testaceous; the two median lines exceedingly sinuous, the elbowed has two very long teeth on the black shade, then it retreats gradually till it reaches the fourth inferior nervule, where it forms a deep sinus enclosing the subreniform spot, and almost touching the inner line, to which it is united by a black dash; subterminal line very faint; usual marginal lunules represented by small black points. Hind wings rosy red; the black band curved, rounded, and abbreviated, with a notch on the outer side, a little before the middle; the black border very broad on the costa, gradually narrowed to the anal angle; ciliæ white, sometimes interrupted with black. Under side of the four wings white, cinereous on the exterior margin, with a blackish submarginal band, a deep black median one, and another near the base; of the hind wings, part red and part white, with a deep black median band, notched as on the upper side, a discal lunule, and a submarginal band, blackish. Length of body 12-14 lines; alar expansion 30-32 lines.

Hab. Toronto, (Dr. Morris). London, C. W., (Mr. Saunders). Montreal and Sorel, (Mr. D'Urban). Orillia, (Mr. Bush). Nova Scotia and United States.

6. C. CONCUMBENS. Walk.—*C. B. M. Noct.* 1198.

"Whitish, speckled with black. Thorax brownish in front. Abdomen pale brownish cinereous. Fore wings glaucous-cinereous, with a very slight brownish tinge; transverse lines incomplete, very slender, with indistinct whitish borders, the interior one with a very prominent tooth; reniform spot almost obsolete; the subreniform with an incomplete black border; submarginal line whitish, indistinct; marginal dots, whitish, pointed with black on the inner side. Hind wings bright rose-color; band broad, curved, nearly regular in its outline, abbreviated towards the interior margin; border broad, gradually decreasing in breadth towards the interior angle, with a narrow rose-tinted space between it and the white ciliæ. Length of body 9-10 lines; alar expansion 26-28 lines." (*Walk.*)

Hab. Cobourg. London, C. W., (Mr. Saunders). Orillia, (Mr. Bush). Montreal and Sorel, (Mr. D'Urban).

7. C. ILIA. Cram.—Walk. *C. B. M. Noct.* 1198. Guén. *Noct.* III. 91.

Dark cinereous. Thorax with black marks. Abdomen slightly crested, whitish beneath. Fore wings dark cinereous shaded with brown and black; a light colored patch at the apex; elbowed line thick, black, partially edged with white, with two moderately long teeth; the two interior lines not very distinct; the subterminal whitish, serrate, well defined; a not very distinct triangular black spot joined to the basal mark; reniform spot testaceous with a whitish margin edged with black; subreniform spot round, light colored, encircled with black. Hind wings deep red, with the base and inner margin covered with black hairs: the black median band very irregular, twice contracted, broad on the costa, attenuated on the inner margin; border rather broad, black, with two sinuses near the middle on the inner side; ciliæ testaceous, reddish at the apex. Under side of the fore wing whitish tinged with red, with the three black bands of the hind wing red, in front whitish, with a black band and border corresponding to those on the upper side, ciliæ of both wings white edged with black, and scalloped. Length of body 12 lines; alar expansion 27 lines.

Hab. London, C. W., (Mr. Saunders). United States. Jamaica.

8. C. UXOR. Guén. *Noct.* III. 92. Walk.—*C. B. M. Noct.* 1199.

Brownish cinereous. Abdomen cinereous white beneath, crested on the first three or four segments. Fore wings powdered with a yellowish gray, clouded with black and white; near the apex on the exterior margin there is a dark cloud, black in some specimens, extending as far back as the elbowed line; the whole of the inner margin is covered with a similar blackish cloud which occupies about a third of the wing; transverse lines rather indistinct; the elbowed with two very long teeth, projecting into the exterior cloud; subterminal line white edged with brown internally, zig-zag; reniform spot margined with blueish white; subreniform paler, of an irregular shape, sometimes indistinguishable. Hind wings of a bright rich red color, with black hairs at the base and on the inner margin; the black median band broad on the costa, with a regular sinus in the middle, then dilated and hollowed again, and very much narrowed towards the margin of the wing; black border broad, diminishing regularly to the anal angle; ciliæ dark, white at the apex. Under side of the fore wings cinereous at the base, then a red band, next a black one, a narrow white one, and a broad black border, cinereous towards the apex; of the hind wings red, with a narrow black band which is irregularly curved till it passes the middle, when it suddenly forms a V-like mark; discal lunule black, well-defined. Length of body 7-10 lines; alar expansion 18-24 lines.

Hab. London, C. W., (Mr. Saunders). Toronto, (Dr. Morris).

*9. C. ULTRONIA. Hübn.—Walk. *C. B. M. Noct.* 1197. Guén. *Noct.* III. 89.

Cinereous fuscous. Fore wings whitish cinereous, with a very broad black posterior fascia, and a black marginal patch; a bluish shade on the disc: reniform spot hardly visible. Hind wings bright vermillion red, with a broad black border, and a very much curved black median band, reaching the inner margin; ciliæ blackish, white at the apex.

Hab. Orillia, (Mr. Bush). United States.

10. C. CERQGAMA. Guén. *Noct.* III. 96. Walk. *C. B. M. Noct.* 1202.

Cinereous, clouded with black and white. Abdomen cinereous. Thorax with brown bands in front. Fore wings slightly powdered with ferruginous scales; two broad oblique whitish bands proceeding from the costa about half way across the wing; median transverse lines black, distinct; the inner one flexuous; the elbowed denticulated, with two prominent teeth; the subterminal white, running parallel to the elbowed line; marginal lunules black, edged with white exteriorly; reniform spot blackish, with ferruginous scales, and a light margin; subreniform oblong, white. Hind wings black, with dark luteous hairs at the base; a bright yellow fascia across the middle, slightly flexuous, and of equal width throughout; a narrow oblong luteous spot at the apex; ciliæ luteous, with three black bands on the

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*The species marked with an asterisk (*) in the present paper have not come under the observation of the writer; should any one, therefore, recognise the descriptions, he will be much obliged for specimens of those so marked.

fore wings, of which the basal one is paler than the other; and two on the hind wings, discal lunule indistinct. Length of body 11-13 lines; alar expansion 30-32 lines.

Hab. Cobourg. London, C. W., (Mr. Saunders). Orillia, (Mr. Bush). Montreal, (Mr. D'Urban). Trenton Falls, New York.

†19. C. NEOGAMA. Abbot.—Walk. *C. B. M. Noct.* 1202. Guén. *Noct.* III. 96. Westw. *Nat. Libr.* xxxvii. 1202, pl. 26.

Cinereous speckled with black. Abdomen lutescent. Fore wings cinereous, clouded with fuscous and black; the two median transverse lines well defined black; the elbowed commences above the reniform spot, then proceeding outward, forms two nearly equal prominent teeth, between the first superior and the second inferior nervules; it next retreats a little, forming three short rounded teeth, after which it recedes just above the sub-median nervure, nearly as far as the inner line, returning again parallel to it: the subterminal line whitish, irregularly flexuous, with a narrow brownish space between it and the elbowed line; submarginal lunules black, edged exteriorly with white; reniform spot brownish, edged with white; subreniform white with a few dark scales, and a black margin: there is also a rather vague oblique black stripe proceeding from the upper tooth of the elbowed line to the exterior margin and forming a lighter gray apical patch. Hind wings of a rich ochre-yellow color, dull towards the base and inner margin; the black median band very much contracted on the disc, and afterwards twisted almost like an S, and very narrow, near the sub-median nervure, and towards the inner margin, which it does not reach, the black border is very broad on the costa, narrowed posteriorly, with a sharp sinus between the fourth inferior and the sub-median nervures; ciliæ and apical spot luteous. Under side of the fore wings like that of *C. cerogama,* but rather more yellow, with the median band narrow, very much twisted, almost interrupted on the independent nervure, and abbreviated at some distance from the inner margin; the black border rather narrow, flexuous on its inner edge, abbreviated, with dirty-yellow space, sprinkled with black, between it and the exterior margin. Length of body, 12 lines; alar expansion, 35 lines.

Hab. Kingston, C. W., (Mr. Rogers). New York.

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†Since this article was prepared, the writer received specimens of two species of Catocala, from Mr. R. V. Rogers, Jr., of Kingston, C. W. One C. PARTA, described above on page 7, the other C. NEOGAMA, of which a full description is now given.

*11. C. ANTINYMPHA. Hübn.—Walk. *C. B. M. Noct.* 1203. *Melanympha,* Guén. *Noct.* III. 98. *Paranympha,* Drury. *Affinis,* Westw.

Blackish cinereous. Abdomen black ferruginous. Fore wings with a black transverse angled line: reniform spot fuscous with a black margin; subreniform brownish gray, encircled with black; subterminal line cinereous. Hind wings broadly fuscous at the base and at the inner margin; with two very undulating luteous fasciæ, and an elongated luteous spot at the apex; ciliæ pale.

Hab. Canada. New York.

*12. C. POLYGAMA. Guén.—*Noct.* III. 105. Walk. *C. B. M. Noct.* 1207.

"Whitish. Fore wings with a slight pale glaucous-green tinge from the base to the exterior line, the latter having two prominent teeth, of which the fore one is more prominent than the hind one; a broad ferruginous line near the base bordered by two black lines, and a diffuse band of the same hue beyond the exterior line; space between the latter band and the black marginal dots gray, including the indistinct brownish submarginal line; reniform spot partly bordered with black and inclosed in a white space; subreniform spot bordered with black. Hind wings luteous, brown along the interior border; band excavated in the middle, much curved, joining the brown part; border with the usual hindward notch, a small apical luteous streak; ciliæ pale, with brown marks.

Var.—Fore wings with the ferruginous hue almost obsolete; subreniform spot larger. Hind wings with the border interrupted. Length of body 8 lines; of the wings 18 lines." (*Walk.*)

Hab. Orillia, (Mr. Bush).

The following species are found in the neighbouring States, many of them, therefore, are likely to be met with in Canada.

BB.

*13. C. NURUS.—Walk. *C. B. M. Noct.* 1195.

"Cinereous with a very slight brownish tinge. Thorax with brown bands in front. Abdomen with a slight testaceous tinge. Fore wings slightly and partly clouded with brown; a broad dark brown basal streak; the usual transverse denticulated black lines distinct, and the exterior one with two very prominent teeth; a brown streak in the disc towards the exterior border, being a continuation of the basal streak; reniform and hinder spots indistinct. Hind wings rosy red; band broad, curved, excavated on the fore part of its exterior side, not extending to the interior margin; border broad, becoming narrower hindward to the interior angle; ciliæ and the adjoining apical part of the wing, whitish. Length of the body 13-15 lines, of the wings, 32-36 lines.

This species is nearly allied to *C. amatrix*, but may be at once distinguished by the broader and more curved band of the hind wings." (Walk.)

Hab. United States.

*14. C. JUNCTURA.—Walk. *C. B. M. Noct.* 1196.

"Dark cinereous. Thorax speckled with white. Abdomen pale cinereous. Fore wings very slightly and partly clouded with black; the usual transverse denticulated lines indistinct, slightly and diffusedly bordered with brown; reniform spot blackish, slightly marked with brown, as is also the adjoining hinder spot; marginal lunules black. Hind wings red-lead colour, margin red towards the base; band rather narrow, nearly straight, with some slight excavations, curved near its hind end, terminating at some distance from the interior margin, but with its extension indicated by a few black hairs; border moderately broad, including a large elongated apical red spot, and some hinder red marginal lunules; ciliæ whitish. Length of the body 14 lines; of the wings 34 lines." (Walk.)

Hab. United States.

*15 C. SELECTA.—Walk. *C. B. M. Noct.* 1197.

"Brown. Thorax in front with blackish bands. Abdomen pale ferruginous brown. Fore wings with incomplete denticulated transverse lines, and with black submarginal dots which have pale exterior borders, reniform spot with a slight ferruginous tinge. Hind wings bright rose-color; band curved, rather narrow, abbreviated at some distance from the exterior border, somewhat excavated before the middle on its exterior side; border very broad, but gradually decreasing in breadth hindward, not extending to the interior angle; ciliæ and contiguous parts of the border pale luteous, with a few brown streaks. Length of the body 15 lines; of the wings 36 lines." (Walk).

Hab. United States.

AA.

*16. C. LACRYMOSA. Guén.—*Noct.* III. 93. Walk. *C. B. M. Noct.* 1199.

Cinereous, speckled with black. Thorax with black bands in front. Fore wings varied with white, partly clouded with black; transverse lines distinct; subterminal one white margined with black exteriorly; submarginal spot black, edged with white. Hind wings black; ciliæ white, with black indentations.

Hab. United States.

*17. C. EPIONE. Drury.—Guén. *Noct.* III. 93. Walk. *C. B. M. Noct.* 1200.

Blackish cinereous. Fore wings with the usual transverse lines black; an exterior fuscous fascia; subterminal line white; marginal lunules black, edged with white. Hind wings black; ciliæ white; under side with a very short white fascia.

Hab. New York. Philadelphia.

*18. C. INSOLABILIS.—Guén. *Noct.* III. 94. Walk. *C. B. M. Noct.* 1200.

Male.—Cinereous, subglaucescent. Fore wings with the transverse lines incomplete; the elbowed forming two very long teeth; subterminal line white; reniform spot indistinct; subreniform incomplete: submarginal spots black. Hind wings black; ciliæ blackish.

Hab. North America.

*20. C. PALÆOGAMA.—Guén. *Noct.* III. 97. Walk. *C. B. M. Noct.* 1202.

Fuscous, speckled with white. Thorax with black bands. Abdomen ferruginous, cinereous. Fore wings with two short oblique white fasciæ; the transverse lines black, denticulated; the subterminal white, angled; margin of the reniform spot black; subreniform black; submarginal lunules black, edged with white exteriorly. Hind wings luteous, fuscous at the base, and on the inner margin; with a black band and broad black border; ciliæ pale.

Hab. United States.

*21. C. MULIERCULA, Guén.—*Noct.* III. 97. Walk. *C. B. M. Noct.* 1203.

Ferruginous fuscous. Fore wings clouded with blackish, glaucescent in the middle; the two median lines distinct, black, approaching each other; the elbowed with two elongate teeth. Hind wings bright luteous, with an interior black vitta, a black band, and a broad sinuous black border: ciliæ stained with black.

Hab. North America.

*22. C. INNUBENS.—Guén. *Noct.* III. 98. Walk. *C. B. M. Noct.* 1203.

Fuscous. Thorax with a rather deep band. Abdomen cinereous. Fore wings with a diffuse black discal longitudinal stripe, including a white spot margined with black; costa white at the apex; a posterior white streak; median transverse lines black, denticulate; subterminal white; submarginal spots black, paler exteriorly. Hind wings rich luteous, with a black band and broad black border; ciliæ paler, marked with blackish luteous at the base.

Hab. United States.

*23. C. MICRONYMPHA.—Guén. *Noct.* III. 102. Walk. *C. B. M. Noct.* 1204.

Chesnut-brown. Fore wings varied with hoary and blackish; the two median lines distinct, remote on the costa, approaching each other posteriorly; the elbowed forming two teeth, the posterior one of which is almost obsolete: reniform spot composed of a black streak; central shade well-determined; subterminal line angled, white. Hind wings luteous, with two blackish basal streaks; a narrow subangular band, and a broad, curved, interrupted border.

Hab. North America.

*24. C. AMASIA. Abbot.—Guén. *Noct.* III. 103. Walk. *C. B. M. Noct.* 1204. Westw. *Nat. Libr.* xxxvii. 205, pl. 26.

White. Thorax speckled with black. Abdomen lutescent. Fore wings with two fasciæ, of which the basal one is brown, the exterior one ferruginous; costa with black marks: median transverse lines incomplete, angled, black; margin of the reniform spot black; submarginal dots black, edged with white exteriorly. Hind wings luteous, with a black abbreviated band, and a black interrupted border: apical spot luteous.

Hab. North America.

*25. C. ILLECTA.—Walk. *C. B. M. Noct.* 1205.

Pale cinereous. Abdomen luteous. Fore wings with the transverse lines, slender and distinct; elbowed line much denticulated with two prominent teeth, the fore one twice as long as the other; reniform spot white in the disc, edged with black; subreniform white with an incomplete black margin. Hind wings luteous; the band almost abbreviated towards the inner margin, excavated on the outer side; border broad; apical spot elongated luteous; ciliæ whitish. Length of the body 13 lines; alar expansion 30 lines.

Hab. United States.

*26. C. NUPTULA.—Walk. *C. B. M. Noct.* 1205.

Cinereous with a slight testaceous tinge. Abdomen testaceous. Fore wings with ferruginous costal marks; median lines obsolete, except the elbowed, which is ferruginous, and has a prominent tooth marked with black; a broad ferruginous streak along the inner margin, attenuated exteriorly; subterminal line and the margin of the reniform spot whitish, indistinct; submarginal dots black. Hind wings luteous; with a fuscous stripe near the inner margin; a black band contracted in the middle; a broad black margin with two indentations on the inner side near the anal angle; ciliæ whitish-testaceous, marked with fuscous. Length of the body 7-8 lines; alar expansion 18-20 lines.

Hab. North America.

*27. C. NUPTIALIS.—Walk. *C. B. M. Noct.* 1206.

"Whitish cinereous. Thorax with a brown band in front. Abdomen testaceous above. Fore wings minutely speckled with black, with a very slight fawn-colored tinge on the exterior part, which includes the indistinct whitish subterminal line; the usual tranverse lines obsolete, excepting some black or dark brown costal marks, the elbowed line visible for nearly half its length from the costa; reniform spot black, curved, subpyriform; submarginal dots black. Hind wings luteous, with a black slightly curved band, which is abbreviated towards the anal angle, near which it has a notch on the inner side; ciliæ pale. Length of the body 9 lines; alar expansion 22 lines." (Walk.)

Hab. United States.

The remaining species found in North America, are the following:—

B.

*28. C. ELECTILIS. Walk. Mexico.

BB.

*29. C. CARA. Guén. Baltimore.

AA.

*30. C. DESPERATA. Guén. Baltimore.

AAAA.

*31. C. CONSORS. Abbot. Georgia.

*32. C. GRYNEA. Cram. Virginia.

*33. C. CONNUBIALIS. Guén. ?

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*34. C. AMICA. Hübn. Georgia, Florida.

*35. C. MESSALINA. Guén. ?

A POPULAR EXPOSITION OF THE MINERALS AND GEOLOGY OF CANADA.

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PART IV.

(Continued from Vol. VII. page 121.)

The various classes and orders of molluscous animals, with the exception of the class *Cephalopoda*, were described in reference to their fossil relations, in the last article of this series. In the present article we resume and complete our rapid sketch of the more prominent features of Canadian Palæontology, bringing Part IV. of our Essay to a close. The concluding portion, or Part V., of the series, embracing a general view of our rock groups, in their topographical, economic, and other relations, will appear in an early number of the *Journal.*

Cephalopoda.—The Cephalopods are the most highly organised representatives of the molluscous type. They possess a distinct head, furnished with large eyes and with a central mouth. The latter contains a pair of horny jaws or "beaks," (somewhat resembling, although in reversed position, the beaks of a parrot), and is surrounded by eight or ten arms, or by a greater number of tentacles, serving partly for locomotion, but chiefly for prehensile purposes. It is from the possession of these arms or tentacles, viewed as organs of locomotion, that the class derives its name of *Cephalopoda* or "head-footed." Its species are entirely marine. The Nautilus, the Argonaut or "Paper Nautilus," and the Sepia or Cuttle-fish, may be cited as characteristic living types.

The Cephalopods fall into two orders or leading groups, viz.: (1.) *Tetrabranchiata* or *Tentaculifera;* and (2.) *Dibranchiata* or *Acetabulifera.* The tetrabranchiate or tentaculiferous cephalopods possess four branchiæ or organs of respiration, numerous simple or unarmed tentacles, and a many-chambered shell. The dibranchiate or acetabuliferous cephalopods have only two branchiæ, and eight or ten arms; but the latter are provided on the inside with special organs of prehension in the form of *acetabula* or "suckers." These forms also possess a so-called "ink-bag," or internal sack, containing a dark fluid secretion which the animal can eject into the surrounding water when pursued or otherwise alarmed. A single genus, the Argonaut, inhabits a one-chambered shell. All the other genera are "naked," or without external shells, as seen in the Cuttle-fish. These dibranchiate cephalopods exhibit the higher organization, and approximate in some respects to the class of Fishes. Our Canadian rocks offer, however, no fossil representatives of this group, so abundant in existing Nature, and also to some extent so characteristic of the Mesozoic periods of the Earth's history. The tetrabranchiate cephalopods, on the other hand, are almost extinct. The Nautilus is the only remaining type; and of this, no more than two or three living species are known; whilst from rocks of various ages, upwards of 150 fossil species have been collected.

The shell in the tetrabranchiate group is divided into a number of compartments or chambers, by concave, sinuous, angulated, or highly-lobed partitions, called "septa"—the animal inhabiting the outer chamber—and it is traversed, throughout its entire length, by a tube or "siphuncle" of variable form and position. In the Nautilus, according to Professor Owen, this siphuncle opens into the cavity which contains the heart; and its use, although still doubtful, is thought to be to keep up the vitality of the shell in parts distant from the creature's body. It passes through the various chambers without affording any communication between these, so that the old idea respecting the use of the tube, and according to which the animal was thought by its means to be able to fill the chamber with water, or to eject this, in order to sink or rise at will, is now altogether exploded. Under ordinary conditions the nautilus appears to creep on the sea-bed, head downwards, at moderate depths, and to feed on holothuriæ, star-fishes, crustacea, &c. The accompanying diagrams, fig. 126, exhibit the marginal outline of the more general kinds of septa presented by the shells of this group. A simple septum of the *orthoceratites* and *nautilus* are represented by *a*; an angulated septum of the *goniatites* by *b*; a lobed and denticulated septum of the *ceratites* by *c*; and a foliated septum of the *ammonites*, *baculites*, *hamites*, &c., by *d*.

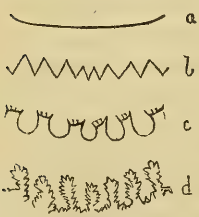

Fig. 126.

In accordance chiefly with these characters, the Tetrabranchiata, or chambered cephalopods, may be classed as follows:

Family I., NAUTILIDÆ.—Septa with entire or slightly sinuous margins. Siphuncle, variable.

Sub-Family 1, *Gomphoceratidæ.*—Aperture of shell partly closed, or much contracted.

Sub-Family 2, *Orthoceratidæ*, or *Nautilidæ proper.*—Aperture more or less open.

Family II., AMMONITIDÆ.—Septa prominently lobed. Siphuncle "external," or along the apparent back of the shell.

Sub-Family 1, *Goniatidæ.*—Septa angulated, *i. e.*, with angular lobes.

Sub-Family 2, *Ceratidæ.*—Septa lobed and denticulated.

Sub-Family 3, *Ammonitidæ proper.*—Septa foliated.

The Ceratidæ and Ammonitidæ proper are entirely restricted to rocks of Mesozoic age, and are consequently unknown among Canadian fossils. (See the Table of Formations given at page 453 of Vol. VI., and also those of Canadian occurrence on the succeeding page). The sub-families of the Gomphoceratidæ, Orthoceratidæ, and Goniatidæ present Canadian examples; but those belonging to the first and last of these sub-families, are few in number and of comparatively rare occurrence; and even the Orthoceratidæ, though rich in examples, are confined, with us, to a small number of genera. It is not necessary, therefore, in describing these forms, to adhere to any close system of classification, more especially as the fragmentary or otherwise imperfect condition in which the fossil cephalopods of the lower rocks so generally occur, forbids in many instances the strict application of definite structural characters. This understood, our Canadian genera may be conveniently described in the following order: *Orthoceras* (including *Gonioceras*, &c., as explained below), *Cyrtoceras*, *Phragmoceras* (belonging to the first sub-family, but placed here, for convenience, as allied by form to cyrtoceras), *Lituites*, *Nautilus*, and *Goniatites*. Other genera, enumerated by palæontologists, and occurring with us, are distributed under one or more of these types.*

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* Many of the genera hitherto established for the Tetrabranchiate Cephalopods can only be regarded as provisional. Characters until recently considered of generic value (and on which distinct genera have been founded by Pictet, D'Orbigny, Hall, and other palæontologists of authority), are now shewn to be more or less inconstant, and consequently of uncertain application. The siphuncle in its form and position, as regards at least the types with simple septa, appears more especially to be a character of this kind; but it may be questioned whether the mere shape of the shell, although a readily observable character in most instances, and hence a convenient one, is actually of any greater value. It would seem, for example, that relations quite as close must have obtained between an orthoceras with ordinary siphuncle and a slightly curved cyrtoceras—as between the former and an orthoceras (or endoceras) with a laterally-situated siphuncle of large size and more or less aberrant structure.

Orthoceras.—In this genus the shell is straight and conical, tapering more or less gradually from the body chamber to its other extremity. The septa are simply concave, or slightly sinuous, and at comparatively short distances apart. If we imagine the shell of a nautilus unrolled and straightened out, we have the typical orthoceras shell. The siphuncle is variable, both in shape and position. Three convenient, if not strictly natural, sub-genera, *Orthoceras proper*, *Ormoceras*, and *Endoceras*, may be founded on its characters. The genus ranges from the Lower Silurian into the Triassic formation. In many of its examples, the shell, if perfect, would shew a length of several feet.

The first sub-genus, *Orthoceras proper*, has a siphuncle in the form of a narrow tube, central or sub-central in position. *O. lammellosum* (fig. 127) and *O. bilineatum* (fig. 128), both from Lower Silurian Strata, are Canadian examples of common occurrence.

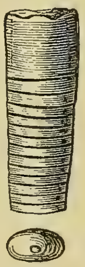

Fig. 127.

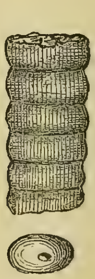

Fig. 128.

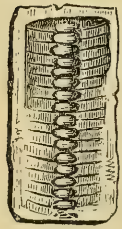

Fig. 129.
A worn fragment shewing siphuncle and septa.

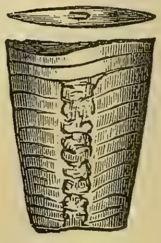

Fig. 130.

The second sub-genus, *Ormoceras*, comprises the various orthoceratites (as the species of the genus Orthoceras are collectively termed) with moniliform or "beaded" siphuncle, as shewn in *Ormoceras tenuifilum* (fig. 129) from the Trenton limestone and lower beds. This sub-genus includes the Huronia and Actinoceras of authors, and also the peculiar flattened species named *Gonioceras anceps* by Hall. This latter form is an Orthoceras with beaded siphuncle and slightly sinuous septa, and with a shell so compressed as to offer almost trenchant edges. Fig. 130 represents a fragmentary specimen. The species is very common in the Chazy and Black river limestones at the lower part of the Trenton group. In weathered specimens, both of this and other species of *Ormoceras*, the outer portion of the shell is often obliterated, when the beaded siphuncle with its attached septa, has a certain resemblance to the vertebral column of a fish. Weathered specimens of this kind are usually described by quarrymen and farmers as fish remains ; but no vestiges of a true fish, or other vetebrated type, have as yet been discovered in our Silurian strata.

In the third sub-genus, for which, without regard to the supposition originally involved in the term, Prof. Hall's name of *Endoceras* may be retained, we may place the orthoceratites with very large and laterally-situated or more or less marginal siphuncle. *Endoceras proteiforme,* of Hall, (fig. 131), is a familiar Canadian example. The siphuncle, in this species, often contains a long cone of calcareous matter, made up of successive layers. This secretion probably served to counterbalance the increasing buoyancy of the shell, as the air-chambers during the growth of the latter became more and more numerous. The shells of smaller orthoceratites are also sometimes found, with other accidental bodies, in the interior of these large siphuncles. Examples of *Endoceras proteiforme,* five or six inches in diameter, and in fragments of over eighteen inches or two feet in length, have been obtained from the Trenton limestone of Nottawasaga township, near Collingwood, C. W. ; also from Belleville ; and from the Hudson River beds of the River Humber, near Toronto, as well as from other parts of the Province. One of the largest specimens, yet collected, was obtained by the writer from the shores of Georgian Bay, (Lake Huron,) and is now in the Museum of the Toronto University.

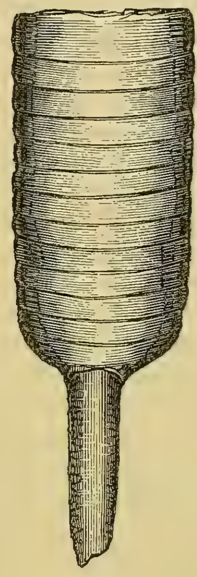

Fig. 131.

NOTE :—We have retained for the orthoceratites described above, the specific names by which they are familiarly known in Canada, after the determinations of Prof. Hall in his "Palæontology of New York." But *Orthoceras lamellosum* is probably identical with the European species, *O. regulare;* whilst *O. tenufilum* may perhaps be referred to *O. cochleatum* (Schlotheium); *O. bilineatum* to *O. calamiteum* (Munster); and *Endoceras proteiforme* to Schlotheim's *O. vaginatum. Gonioceras anceps,* on the other hand, is quite distinct from the *Orthoceras anceps* of De Koninck, and also from the earlier and doubtful *O. anceps* of Count Munster. An extended discussion of synonymes, or minute comparison of specific details, would be quite out of place, however, in an Essay of the present character.

Cyrtoceras:—This genus includes the *curved* orthoceratites with normal shell-aperture. The septa are simply concave, or slightly sinuated, and the siphuncle variable. Its forms, as at present known, may be arranged under two sub-genera, representing the first and third amongst the straight or true orthoceratites. The genus ranges from the lower Silurian into the Carboniferous formation.

The first sub-genus, *Cyrtoceras proper,* has a gradually tapering and more or less slightly curved shell, with small siphuncle: the latter occupying a central or sub-central position, or lying along the larger curve of the shell. Fig. 132 is a sketch of *C. annulatum* from the lower part of the Trenton group.

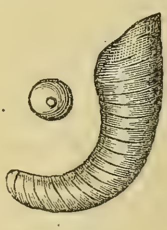

Fig. 132.

In the second sub-genus, characterised by a large siphuncle as in the endoceratites, we may place the *Piloceras* of Salter. This form presents short, thick, and slightly curved shells with large siphuncle. The latter often contains a cone of calcareous matter, as in *Endoceras proteiforme.* The type, as yet, is comparatively rare, but a species has been discovered in the Calciferous Sand Rock of the Mingan Islands, by Sir William Logan and Mr. Richardson. This is described by Mr. Billings in the *Canadian Naturalist,* Vol. V., p. 171. In making *Piloceras,* however, merely a sub-genus of *Cyrtoceras,* as explained above, we follow our own views.

Phragmoceras:—This genus, in form, is closely allied to *Cyrtoceras,* and is also confined to Palæozoic rocks. The shell is curved, and the septa simple or slightly sinuated; but the aperture of the shell is more or less strongly contracted. The siphuncle is variable, although in most species hitherto referred to Phragmoceras, it lies along the shorter curve of the shell. In the Bohemian *P. perversum* of Barrande, and in the *P. præmaturum* of Billings, it occupies, nevertheless, the convex side. Fig. 133 represents a fragment of the latter species (after Billings), from the Black River Limestone of La Cloche Island, Lake Huron.

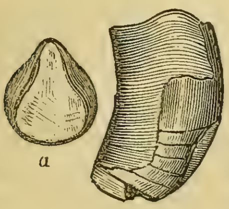

Fig. 133.
a. Represents the aperture.

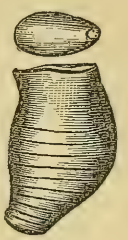

Fig. 134.

To this genus, Hall's *Oncoceras constrictum* (fig. 134) should also be referred. This species is exceedingly common in the low part of the Trenton group ; but when in imperfectly preserved specimens, it cannot be distinguished from a cyrtoceras. The siphuncle is near the outside or larger curve of the shell.

Lituites:—The shell in this genus, is involute or "rolled u (like that of the nautilus) for a certain distance, and is then projected in a straight line. The septa are simply concave, and the siphuncle of small size and mostly central. Species have not been found as yet above the Silurian rocks. In fragmentary specimens, however, it is often impossible to determine the genus—the straight part of the shell resembling that of an orthoceras with narrow siphuncle, and the involute portion being identical with the shell of a nautilus. Fig. 135 represents the *Lituites undatus* of Hall. Examples having a general resemblance to this, but (as first pointed out by the writer) with external siphuncle, occur in our Lower Silurian beds, at Lorette near Quebec, and elsewhere.

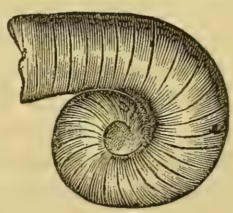

Fig. 135.

Nautilus.—This genus is one of peculiar palæontological interest, as the only living type of the great group of tetrabranchiate cephalopods, or those inhabiting a many-chambered shell. It passes (although with diminished, and, of course, with changing species) from the Silurian epoch into the existing age—its fossil representatives traversing the rocks of all intervening periods. The shell is involute, the septa simple and mostly central in position. Our Canadian examples are scarce, and have not yet been thoroughly determined.

Goniatites.—This genus first appears in Devonian strata, and becomes extinct in the Triassic deposits. It belongs, as already stated in our introductory remarks, to the family of the Ammonitidæ, and is essentially characterized by its angulated strata (see fig. 126, above). The shell is involute in form, like that of the nautilus, and the siphuncle external and of small size. Several species occur in the Devonian rocks of Western Canada, but the relations of these have not yet been fully worked out.

As already explained on a preceding page, the second or Dibranchiate Order of Cephalopods—comprising the Argonaut, the Octopus or "Poulpe" of the French, the Loligo, (more familiarly known as the Calamary or Squid), the Sepia or Cuttle-Fish, the extinct Belemnite, and other kindred genera—are without representatives in rocks of Canadian occurrence.

Articulated Animals.—The forms of the sub-kingdon *Articulata* (see vol. vi., p. 5,) are arranged in the following classes :—ANNELIDA, CIRRHOPODA, CRUSTACEA, ARACHNIDA, MYRIAPODA, and INSECTA; but of these, the annelids, cirrhopods, and crustaceans are alone represented by fossil examples in Canadian rocks.

ANNELIDA.—The annelids comprise various worm-like forms, and are usually grouped in three Orders :—*Abranchiata*, *Dorsibranchiata*, and *Cephalobranchiata*. The abranchiate annelids are without any visible or external branchiæ. They include the common earth-worms and other forms unrepresented in the fossil state. The dorsibranchiate annelids are marine worms with tufts of branchiæ in the form of delicate filaments at regular distances along the sides of the body. They offer a few fossil species, but have not been recognized in Canadian rocks. Finally, the cephalobranchiate annelids, also marine types, possess thread-like branchiæ around the mouth or head. Some of these forms secrete a calcareous tube or shell for the protection of the worm-like body. These constitute the genera *Serpula* and *Spirorbis:* the former having an irregular wavy tube, whilst in the latter the tube is spirally rolled up. These tubes are mostly attached to the backs of shells or other sub-marine bodies. A fine species of serpula, *D. splendens*, seven or eight inches in length, and a quarter of an inch across the opening, has been described by Mr. Billings from the Chazy limestone of the Lower Silurian Series (*Canadian Nat.*, vol. iv., page 470). Other genera of cephalobranchiate annelids form a protecting tube or sheath of fragments of shells or grains of sand (*Terrebella, Sabella*); but our rocks have not yet offered any examples of these.

Cirrhopoda.—The cirrhopods form a small group of marine animals, sedentary in their adult condition, and more resembling mollusks at first sight than members of the articulated series. They secrete an external many-valved shell, and possess a number of delicate plume-like cirrhi, or so-called "arms," capable of protrusion beyond the shell, and of thus creating currents in the water, by which food is brought within the creature's reach. There are two more or less distinct types: *pedunculated* and *sessile* cirrhopods. In the former, to which the well-known barnacles belong, the animal is attached, head downwards, to ships' bottoms, pieces of floating timber, &c., by a kind of semi-corneous stem; whilst in the latter, typified by the *balanus* or "sea acorn," the shell is fixed directly by its base to rocks and other sub-marine bodies, or to such as lie between the tide-marks.* Fig. 136 represents a group of several *balani*, to shew the general form of the shell. Fragments of one or two species occur in our Post-Tertiary or comparatively modern deposits, at Beauport and elsewhere in Eastern Canada (see Part V.); but no cirrhopods are met with in our lower rocks. The *balanidæ*, indeed, appear to date only from the Tertiary age, although the *anatifidæ* or pedunculated forms exhibit representatives as low down as the Jurassic series, and perhaps in still older deposits.

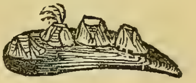

Fig. 136.

Crustacea.—This important class, abundant at the present time in genera and species, is sub-divided into a considerable number of Orders; but, of these, two only, embracing the *Cyproids* and the *Trilobites*, present examples of common occurrence in Canadian rocks. The higher and more typical forms of the crustaceans—the *Decapods*—comprising the various lobsters, crabs, and other allied species—offer no representatives below the Carboniferous formations.

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* The balani, though usually fixed to stationary bodies, are sometimes, like their cousins the barnacles, fated to a more or less migratory life. We carried off surreptitiously from a public dinner table, a short time ago, the beak or projecting part of the head-covering of a large lobster, to the extremity of which a full grown balanus was attached. The specimen may be seen, by the curious in such matters, in the Museum of the Toronto University.

Cyproids, or *Bivalve Entomostracans.*—The crustaceans of this order are more or less minute forms, partly inhabitants of the sea, or of brine solutions, and partly of fresh water. The existing marine types belong mostly to the genus *Cythera* or *Cytherina*: the others to the genus *Cypris*. In each, the form is closely alike; and in fossil species the one is scarcely to be distinguished from the other, except by its associated fossils. In living forms, the minute animal is seen to possess a delicate bivalve shell, with curious tufted feet and antennæ, which it projects beyond the shell when swimming. These little crustaceans occur in rocks of all ages, and much resemble, in the fossil state, small scattered grains or seeds (fig. 137). The shell is frequently brown and lustrous, and usually oval or semi-circular in shape. Canadian genera (Organic Remains, Decade IV.,) have been referred to *Beyrichia*, *Leperdita*, &c., but their characters are quite microscopic and more or less indistinct.

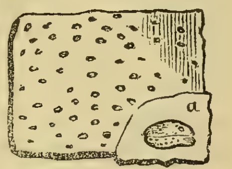

Fig. 137.
a. = Magnified Specimen.

Trilobites.—This order is entirely extinct. Its representatives—evidently marine types—are confined to the lower and middle portion of the Palæozoic series; or range, in other words, from the earliest fossiliferous rocks into the base of the great Carboniferous formation. Above the deposits of the latter geological horizon, not a trace of a trilobite has been discovered. The nearest existing type to this extinct group, appears to be the *Limulus*, or "King-crab"—a form which must be familiar to all who have visited the New England coast.

The shelly covering of the back, with a portion of that which protected the under side of the head, are the only parts of these crustaceans which have been preserved to us. The back (see fig. 138) consists of three principal parts: the *Buckler* or *Head-shield, H;* the *Body* or *Thorax, T;* and the *Pygidium* or *Caudal-shield, P.* The shell, moreover, in most instances, is strongly tri-lobed by two longitudinal furrows, as shewn in the figure. From this character the order derives its name.

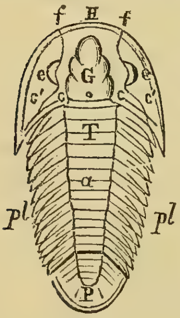

Fig. 138.

In the centre of the head-shield there is usually a distinctly raised portion (= G in fig. 138) called the *glabella.* It is bounded laterally bythe two longitudinal furrows mentioned above; and is either smooth, or variously lobed, furrowed, or granulated. In some genera it expands anteriorly, or towards the upper part; and in others it becomes contracted in this direction. The head-shield in most genera exhibits also on each side of the glabella a sutural line—called, technically, the *facial* suture—as shewn at *f f* in Fig. 138. The direction of the facial suture differs somewhat in different genera, as explained in our descriptions of these, below. In some few (as in Trinuclens) again, it is either absent, or concealed by being situated along the edge of the shield. The eyes (*e e*) when present, occur on each side of the head-shield, in the line of the facial suture, as shewn in the figure. They are compound, as in existing crustaceans, insects, &c.; and the component facets in certain genera (*Dalmannites, Phacops*) are thrown up in strong relief, forming the so-called *reticulated eye.* In other trilobites the reticulation is less distinct.* The sides of the head-shield or "cheeks," (*c c*), often separate along the facial suture, and are found detached. The shell is continued over the head-shield; and under the glabella, where the mouth was situated, a so-called *hypostoma* or *labrum* is occasionally found. This, which is also and more commonly met with in a detached state, is generally of an oval form; but in the genus *Asaphus* (see below) it is hollowed out into a fork, or is somewhat of a horseshoe shape. The hinder or lower extremities of the head-shield are rounded in some species, whilst in others they terminate in long or short horns.

The body or thorax of the trilobite is composed of a series of separate rings or segments, varying in number in different genera. Each segment is sub-divided into three parts by the two longitudinal furrows already alluded to. The middle part, or that between the furrows, is generally known as the *axis,* whilst the outside portions are called sides or *pleuræ.* These latter have their ends rounded in some species, and pointed, or even prolonged into spines, in others. In some, also, there is a raised band on each pleura, and, in others, a groove or furrow. Detached segments, or the three-curved impressions of these, shewing their trilobed character, are frequently seen in our Utica Slate and other fossiliferous rocks. The greater or less degree of mobility with which the thoracic segments were endowed, permitted the trilobites to bring the under parts of the caudal and head-shields together, both for the protection of the soft or undefended parts of the body, and also, in all probability, to enable the creature to sink with greater rapidity into deeper water during moments of danger or alarm. Specimens in this "rolled up" condition are of very common occurrence (see fig. 143 *a*, and 144).

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* In the genus *Harpes,* according to Barrande, the eye is pseudo-compound, consisting of simple stomata in merely approximate union. See an article by the writer, on the classification-characters, &c., of the Trilobites, in this *Journal,* Vol. I., pp. 271-286.

The shell covering of the *pygidium* or "tail" (*P* in fig. 138), consists of a single or entire piece: or rather, perhaps, of various consolidated segments. It is very generally met with detached from the other portions of the body. Its outline is either rounded, pointed, or digitated; and it sometimes terminates in a long spine, or exhibits several spinous processes. In some genera it is very small, whilst in others it equals the head-shield in size.

The more important genera and species of Trilobites, occurring in Canadian rocks, are enumerated below:

Trinucleus.—Head-shield surrounded by a perforated border; glabella, globose and strongly pronounced; eyes, wanting. Six body-rings. Caudal-shield of moderate size. *T. concentricus* (fig. 139), of the Trenton and Hudson River Groups, is our only species; but examples of this (in a more or less fragmentary state) are common. When perfect, the corners of the head-shield terminate in horns, and a spine projects backwards from the base of the glabella. Average length one to two inches.

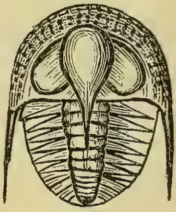


Fig. 139.

Asaphus.—Head, thorax, and pygidium, of about equal size. Glabella smooth or slightly furrowed, and not much raised. Eyes tolerably near together. Hypostoma forked. Body-rings, eight in number. Our two most common species comprise *A. platycephalus*, formerly called *Isoteles gigas* (fig. 140), with rounded head-angles and nearly smooth pygidium, chiefly from the Trenton Group; and *A. Canadensis* (Fig. 141), with head-angles terminating in points, and with furrowed pygidium, from the Utica Slate deposits. Fragments of this latter form, and sometimes entire specimens, occur in great abundance at Collingwood and at Whitby (see *Canadian Journal*' Vol. III., p. 230). The forked hypostoma is shewn at *a* in the above figures. Another species, *A. megistos*, with smooth pygidium and horned head-shield, is also common in the Trenton Limestone of Cobourg, C.W. The genus *asaphus*, both on this Continent and in Europe, does not pass out of the Lower Silurian series. Examples vary in length from less than an inch to over eighteen or twenty inches.

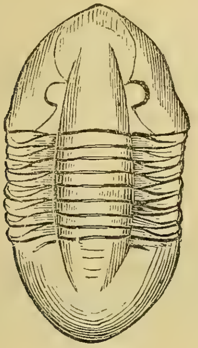
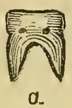


Fig. 140.



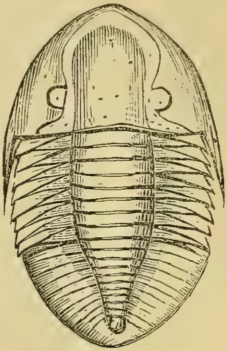


Fig. 141.

Ogygia:—This genus resembles *Asaphus* in its general aspect, number of body-rings, &c., but possesses an *oval* in place of a *forked* hypostoma. It is often impossible to decide, consequently, as to which genus fragmentary examples should be referred. Under *Ogygia*, the *Dikelocephalus* of Dale Owen, and the *Bathyurus* of Billings, should probably be placed. Several species of these, although in a more or less imperfect condition, have been found in the Quebec group (see PART V.) of Point Levi, and also, as regards *Bathyurus*, in the corresponding Calciferous Sand Rock of the Mingan Islands, as well as in the Chazy Limestone of Grenville, &c. The body-rings in the latter type are perhaps nine in number, but few specimens, in which they are complete, have as yet been met with. Fig. 142 represents a fragmentary example of *B. Angelini*, after a figure by Mr. Billings, from the Chazy limestone. A portion of the head-shield of *B. Saffordi*, copied also from Billings, is shewn at *a*. In *Dikelocephalus*, the pygidium has often a deeply serrated or spinose margin; but it may be

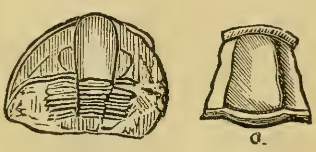


Fig. 142.

questioned whether all the separated caudal-shields referred to that type, really belong to it.* The species are restricted, as far as present observation goes, to the lowest fossiliferous zone.

Illænus :—In this well-characterized genus, the shell-covering is more or less smooth and comparatively free from furrows. Head, thorax, and pygidium are in most specimens nearly equal in size. Glabella broad, but feebly raised or otherwise defined. Eyes far apart. Body-rings generally ten (rarely eight or nine) in number. Pygidium almost or quite smooth, with even, rounded outline. The genus belongs to both the Lower and Middle Silurian deposits, but is chiefly found in the middle and higher parts of the lower series. Fig. 143 represents one of our most common species, from the Trenton and Hudson River groups. It is usually referred to *Illænus crassicauda*. A "rolled-up" example is shewn at *a*.

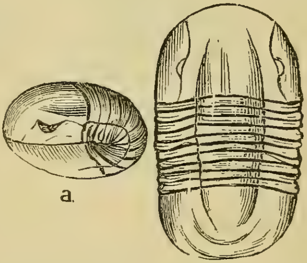


Fig. 143.

Phacops:—Glabella largely developed, expanded anteriorly, and often granulated but not lobed. Facial-suture cutting the sides of the head-shield. Eyes strongly reticulated. Head-angles and pleuræ with rounded ends. Body-rings eleven in number. Pygidium with rounded or entire outline. Range of genus, Lower Silurian to Devonian. *Phacops bufo* (fig. 144) from the Devonian beds of Western Canada, is one of our most characteristic and and best known species.

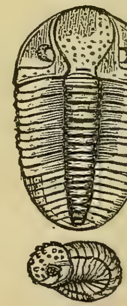


Fig. 144.

Dalmannites :—Like *Phacops*, but with lobed glabella, head-angles extended into horns, and pointed or spinose pleuræ. Pygidium also with more or less spinose margin, or otherwise terminating in a point or spine. Fig. 145 represents *Dalmannites limulurus* from the Niagara group. The caudal spine, in many specimens, is broken off.

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* The caudal-shield referred to *Dikelocephalus magnificus* (*Can. Nat.*, Vol. V., p. 307) appears to have equal if not greater claims to be placed under *Ceraurus*.

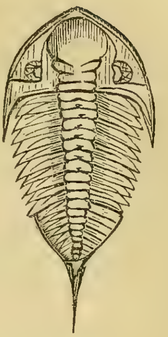

Fig. 145.

The reader will find descriptions of various fragmentary species in papers by Mr. Billings in the fourth and fifth volumes of the *Canadian Naturalist*. He is referred also to that publication for figures of less known or uncertain species of *Illœnus* and other forms of this order.

Ceraurus.—This genus is the *Cheirurus* of European authors. It is more or less closely allied to Dalmannites, but the eyes exhibit only a delicate reticulation, and the pleuræ have a raised band on the surface, in place of a groove as in the latter type. The glabella is large, and furrowed at the sides. The facial suture cuts the side of the head-shield. The angles of the head terminate in points or horns. The pleuræ are also pointed; and the caudal shield has a spinose or serrated outline, or otherwise terminates in one or several horns. Body-rings eleven in number. The genus ranges from Lower Silurian into Devonian beds. A common species from the Trenton Group, *Ceraurus pleurexanthemuus,* is shewn in fig. 146. Impressions of the glabella, and of the two-horned pygidium, are especially abundant.

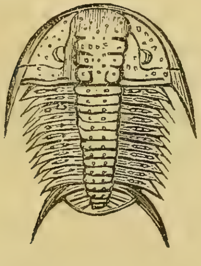

Fig. 146.

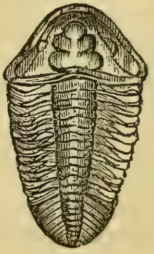

Fig. 147.

Calymene.—The glabella of this genus is prominently developed, lobed, and contracted anteriorly. The head-angles are rounded, and the facial suture cuts these. The body-rings are thirteen in number: pleuræ rounded. Pygidium with entire outline. Our most common species is the widely distributed *C. Blumenbachii* (fig. 147). This species ranges from the Trenton Group into the Middle Silurian deposits. It is very frequently found in a "rolled up" condition.

Homalonotus.—This genus has the same number of body-rings as *Calymene*, and the general shape, direction of the facial suture, &c., is also the same. The glabella, however, although contracted anteriorly, is without lobes, and the two longitudinally furrows, which impart a three-lobed character to the trilobites generally, are here but feebly developed. A common species of the Niagara Group, *H. delphinocephalus* is represented in Fig. 148.

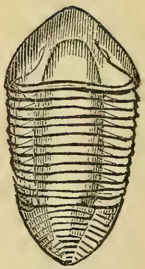
Fig. 148.

Triarthrus.—This genus is also somewhat allied to *Calymene*, but the body-rings are fourteen, or from fourteen to sixteen, in number, and the head-shield and pleuræ, in some species, terminate in points. The glabella is nearly straight at the sides, not much raised, and marked on each side by three short furrows. *T. Beckii*, (fig. 149) of our Utica Schist formation, is the best known species. Impressions of the glabella of this form occur abundantly in the shale beds near Collingwood, and also in the neighbourhood of Whitby, C. W. In *T. Beckii*, each segment of the thorax bears in the centre a short spine. In another species, made known by Mr. Billings under the name of *T. spinosus*, a long spine descends from the neck furrow of the glabella, and another from the eighth body-segment. A third species, *T. glaber* (Billings), is destitute of spines. The two latter forms occur in the Utica Slate of Lake St. John, north of Quebec.

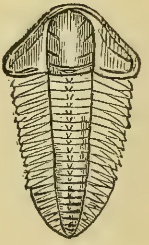
Fig. 149.

Conocephalites.—In this genus, the gabella, though convex, is very short, and the body-rings are fourteen or fifteen in number. Its species are characteristic of the lowest fossiliferous deposits, and are mostly of very small size. The head-shield of *C. Zenkeri*, after Billings, is figured in wood-cut 150 (*Can. Nat.*, vol. v., p. 205). It occurs in the Quebec Group of Point Levi.

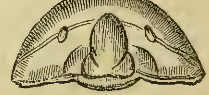
Fig. 150.

Paradoxides.—Head-shield terminating posteriorly in horns; glabella well developed; body-rings over fifteen in number; pleuræ pointed, the second or third pair often longer than the others; caudal-shield, very small. This genus is also characteristic of the lowest zones of fossiliferous strata. Some more or less obscure species, first found in Vermont, have lately been discovered in the Quebec Group of Anse au Loup, on the north shore of the Straits of Belle Isle.

Vertebrated Animals.—Remains of vertebrated forms are of rare occurrence in Canadian rocks. Our Silurian strata are entirely destitute of any signs of these remains, and traces only have as yet been discovered in our Devonian beds. These consist of fish scales and impressions (North Cayuga; St. Marys; Malden; Kettle Point; Bear Creek). In the higher Drift accumulations, the bones and teeth of the Mastodon and Mammoth, the latter an extinct species of elephant (*Elephas primigenius*), are occasionally found; and in these and more recent deposits, the remains of existing forms, such as those of the capelin (*Mallotus villosus*), the lump-sucker (*Cyclostomus lumpus*), the northern seal (*Phoca Grœnlandica*), the Canadian beaver, Wapiti, &c., have also been discovered. No marine forms, however, have been found in these deposits west of Kingston, as explained more fully, in our remarks on the Drift and succeeding period, in the next division of our subject.

NOTE ON GULDIN'S PROPERTIES.

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It is well known that Pappus, the Greek geometer who flourished toward the end of the fourth century of our era, is the author of the remarkable propositions which are generally called "Guldin's Properties of the Centre of Gravity." They occur, without demonstration, at the end of the preface to the seventh book of his *Collections*, and were first printed in the Latin translation by Commandine in 1588. Guldin, in his work published 1635–42, gave the statement of them in the same form with numerous applications, but still without demonstration; and having in this work attacked Cavalleri's method of indivisibles, Cavalleri in reply not only refuted Guldin's attack but employed his method to furnish the demonstration of these theorems, which Guldin had not been able to obtain. The "centre of gravity" referred to in these theorems is the geometrical centre of mean position, as the theorems do not depend on any mechanical principles but are purely geometrical in their nature, and are simple applications of the integral calculus. The usual statement of the first of these "Guldin's Properties" is as follows:

"If a plane area revolve about an axis in its own plane, the volume generated is equal to the product of the area and the length of the path of its centre of gravity."

This statement, however, ought to be limited to the cases where the area lies wholly on one side of the axis, as otherwise the product spoken of is equal not to the whole volume but to the difference of the volumes generated by the parts lying on opposite sides of the axis. This extension is sometimes useful, as, for instance, in the investigation of the metacentre of a floating body. Here, if the displacement be made round the axis passing through the centre of gravity of the plane of floatation, it follows at once that the wedges generated on opposite sides of this axis are equal, and the whole volume displaced therefore remains the same; or, conversely, if the displacement be made so that the volume displaced remains the same, and the wedges on either side of the line of displacement are therefore equal, it follows that this line passes through the centre of gravity of the plane of floatation. This also gives at once the solution of a problem set in the Senate House, 1848: "A plane moves so as always to enclose between itself and a given surface S, a constant volume. Prove that the envelope of the system of such planes is the same as the locus of the centres of gravity of the portions of the planes comprised within S."

If we suppose the axis of revolution in the statement to remove to an infinite distance, we have the case of a plane area moving parallel to itself, while its centre of gravity moves in a straight line perpendicular to the plane of the area, and Guldin's property holds not only with regard to the centre of gravity but also to *every* point of the area. A similar extension applies to the following:

"If a plane area move parallel to itself, its centre of gravity moving in a curve, the plane of which is perpendicular to that of the area, the volume generated is equal to the product of the area and the projection of the path of the centre of gravity on a plane which is at right angles both to the plane of the area and of the path, the projection being always in the same sense."

Another theorem suggested by the above is this:

"If the centre of gravity of a plane area move in a curve, the plane of which is perpendicular to that of the area, and the plane of the area is always inclined at the same angle to the path, the volume generated is equal to the product of the path and the projection of the area on a plane normal to the path at the point."

Another case to which the statement of Guldin's property applies is,—

"If a plane area move so that its centre of gravity describes a plane curve, to which the plane of the area is always normal, the volume generated is equal to the product of the area and the path."

The area in this case must be limited to lie wholly on one side of the evolute of the path at each point.

Another extension is the following:

"If a plane area revolve about an axis parallel to its plane, the volume generated is equal to the product of the path of its centre of gravity, and the projection of the area on a plane passing through the axis and the centre of gravity."

Here also the limitation exists, that the area must lie wholly on one side of the plane drawn through the axis at right angles to the plane of the area.

Similar extensions exist, *mutatis mutandis*, to the second of Guldin's properties. I am not aware that any of the preceding have been previously noticed.

TRANSLATIONS AND SELECTED ARTICLES.

ON THE ORIGIN OF HAIL.

An exceedingly elaborate and interesting article on this subject, from the pen of Frederick Mohr, has appeared in the September number of Poggendorff's Annalen, and as that periodical is not often to be met with in this country, an abstract of the treatise may not be without interest to the readers of the *Canadian Journal.*

The fall from the heavens of masses of ice, sometimes nearly a pound in weight, in hot climates and in the warmest seasons, naturally excited attention from a very early period, and manifold have been the endeavours to account for the phenomenon. The theories proposed however have all proved insufficient, being generally based on a fallacy, and at the present time physicists are generally content to rank the cause of hail as one of the things unknown. Whether Mohr's ingenious explanations may be admitted as satisfactory, is open to question. The writer cannot but believe that the whole theory, beautiful as it is many respects, and offering a satisfactory explanation of many collateral phenomena, is yet open to the same objection as the others, viz., that it is based on a fallacy.

The first theory proposed was that of Volta. He imagined that the sun's rays were entirely absorbed by the upper surface of a dense cloud, thereby causing a rapid evaporation, particularly if the upper stratum of air were dry; by the evaporation so much heat became absorbed or removed that the water contained in the cloud became ice. Here the heat of the sun is supposed to cause evaporation, and simultaneously to remove heat from the aqueous vapour in the cloud, which is obviously absurd. The increase in the size of the hail-stones, was explained by Volta on the supposition that the stones were projected upwards and downwards between two oppositely electrified masses of clouds, like the pith figures in a common electrical experiment, (the noise preceding a fall of hail has also been explained by the rubbing together of the hail-stones during this supposed attraction and repulsion,) but it is difficult to imagine how such heavy masses could be so kept in motion. Whether it be possible or not, if the first part of the explanation is wrong, the second falls to the ground.

In the theory of F. Vogel, it is assumed that the aqueous vapour which is supposed to exist in the clouds, in a vesicular form, can be cooled far below the freezing point without becoming ice, and that when particles of sleet (which are usually observed in the interior of hail-stones) fall from the higher regions of the atmosphere, the aqueous vapour is deposited on them and becomes ice. In this theory the increase of the hail-stone is accounted for, but not the original formation.

Leopold von Buch assumes that a mass of damp air being carried by the ascending current into the upper regions, deposits drops of water which in their descent through the lower and warmer strata evaporate, freeze, and cause a further deposition of water on their surface, which is continuously converted into ice. The same objections, but in a greater degree, apply to this theory as to that of Volta. Water falling from the upper regions, and passing into warmer and moister strata, cannot possibly evaporate so rapidly as to freeze.

"As long as it was believed that dew produced cold, the phenomenon remained inexplicable. Wells inverted the axiom and the problem was solved."—*Dove's Meteorology.*

Mohr does not attempt to account for the production of cold, but assumes it as existing, viz., in the upper regions of the atmosphere. Barral and Bixio found a gradual diminution of temperature up to 21,060 feet, at which elevation the thermometer indicated 39 below zero. (Very recently Glaisher has observed the same, but the change of temperature was not by any means uniform or in one direction.)

In a state of repose the lower strata of air will always be the warmer, heavier, and more saturated with moisture, while the higher strata will be the colder, lighter, and drier. A mixture of two strata may cause the temperature to sink below the dew point, thus causing a deposition of water, and herein, according to Mohr, lies the cause of a much more important disturbance.

(Mohr then proceeds to account for the formation of an enormous vacuum by the sudden conversion of vapour into water; but while it is quite true that a vacuum is produced by the condensation of steam, it seems somewhat doubtful whether the enormous vacuum required by the theory, can be produced by the condensation of the vapour of water contained in air, the volume of which does not depend on the amount of moisture; hence the translator prefers to give the German philosopher's explanation in his own words.)

"A volume of water when converted into vapour at a temperature of 100° C and 760 m m pressure, acquires a volume about 1700 times greater. At lower temperatures the increase is still greater, at 0° 182,323, and at 20° 58224. Aqueous vapour expands according to Mariotte's law under diminished pressure, but under increased pressure a portion of water is formed and the density remains the same. At a height where the stand of the barometer is only 380 m m, *i.e.*, about 18500 feet, aqueous vapour must have double the expansion above mentioned, viz., 3400 at 100°, at 0°

364646 and at 20° 116448. Hence during the condensation of the vapour, an enormous diminution of volume must take place. The vacuum so formed can only be filled from the sides and from above, the colder upper air rushing into the partial vacuum causing still further condensation of water and diminution of volume, and is thus in its turn the cause of the attraction of higher and colder masses of air. In proportion to the rapidity of the condensation of the vapour by the descending current, the superior vertical layers must rush in to fill up the void, and the surrounding horizontal layer will have less time to enter. The less dense masses of air in their descent alter their volume according to Mariotte's law, and this is a second cause of the disturbance of equilibrium, as every mass of air undergoes a great change of volume by a simple change of vertical position.

Hence the mass of air set in motion over the place of condensation, will be in the form of a funnel, and will be larger than the vacuum it is destined to fill in the lower strata. A certain amount of heat will be given out by the compression of the descending air and by the deposition of water, but this will be small in comparison with the cold of the upper strata, the hail will not be quite as cold as the air which forms it.

The formation of hail must commence with that of water, cold air is drawn in from above and the drops of water become frozen, if air from a great height be brought down into the partial vacuum, the masses of ice may be cooled many degrees below 0°, and hence in their descent will cause the general deposition and solidification of water on their surfaces. When an irruption of very cold air takes place, not only may single drops freeze into solid ice but many may join together and form larger masses. The vapour of water is cooled down to the freezing temperature by the descending current, while a solid body (the hail-stone) is present to induce a deposition on its surface. The same cause which produces the hail-stone, is active in forming those depositions of ice on the branches of trees, which are not unfrequently seen during the winter season. It is possible also that the noise which is occasionally heard preceding a hail-storm, may arise from the particles of ice being driven against each other by the rapidly descending masses of air.

Hail can only be formed when so considerable a diminution of volume takes place, that the heavier lateral masses of air have not time to enter, but the lighter vertical portions are alone or principally absorbed. Only in this case is the cold sufficient to form ice. In the hail-cloud we may assume a funnel-shaped vortex (strudel) of ice-cold air, with frozen and liquid water, which descends spirally towards the earth. If this be true, a hail-storm should only be of limited extent, which is well known to be the fact. When the condensation takes place over a large area, the latent heat of the condensing vapour is sufficient to prevent the formation of ice, and an ordinary rain storm results, hail is only formed when the colder air is rapidly drawn into a narrow space.

According to this theory a hail-storm cannot stand still, or continue over one spot for any length of time; it must stop when the lower strata are cooled. But as it progresses in any direction it meets with fresh materials for its reproduction. If we imagine a *hail-funnel* moving onward, its path will be in the shape of a long narrow cleft in the atmosphere, and it is easy to conceive how the force of the hail-storm may continue the same or may even increase, as was the case with the notorious hail-shower which passed through France and Holland in 1788.

Hail belongs essentially to temperate climates, it is not observed in the tropics or in high northern latitudes. In the latter the air is cold and dry, no considerable vacuum can be formed, and hence no sudden entry of cold air. The most severe hail-storms occur in Sicily, the south of France, and the coasts of the Mediterranean. (Very enormous single hail-stones have also been observed in the middle States of the Union.) In the tropics the lower strata of air are so hot that when a commingling of two masses takes place, the latent heat of the condensing vapour is so great as to prevent the formation of ice, and even to cause the descending rain to possess a remarkably high temperature.

Hail is observed more frequently after mid-day than before, oftener by day than by night, because the lower atmosphere is then warmer and moister.

According to this theory we should imagine that windy weather would be unfavourable to the formation of hail, and that any disturbance occurring on still sultry weather would tend to its formation. This is found to be the case.

Hail indicates a storm or tempest, (Gewitter,) but a storm need not be accompanied by hail, the latter is only a phase of the phenomenon, depending on peculiar circumstances. A storm may be formed in the immediate neighbourhood, or may approach from a distance; the latter kind is most violent, as the vacuum has been prolonged to the surface of the earth through the warmest and moistest strata, while in the former it has been only partially produced in the upper and drier regions.

When the atmosphere is strongly warmed and laden with moisture, after a continuance of sultry weather, the first indication of the formation of a storm appears as a veil (flor) overspreading a portion of the heavens, and in which, after a time, darker spots are formed assuming the appearance of clouds. Gradually the dark-grey or black colour of the cloud increases, shewing the great elevation at which the condensation is being effected. A flash of lightning passes through the darkening mass, and streaks of rain are almost immediately perceptible. Now the storm begins to move, and takes a certain direction quite independent of the wind. The rain as it falls to the ground, is accompanied by a strong current of descending air, which is clearly shown by the bending down of the flexible branches of poplars, by the flattened appearance of well foliaged fruit trees, and by the whirling rise of leaves and dust from the surface of the ground. A sultry calm precedes the storm, while immediately after its passage a similar stillness ordinarily prevails. The tempest cannot have been brought by the wind, but must have brought or produced it. The condensation of water, sufficiently rapid to produce a tempest, can only take place in still weather, during prevalence of wind only general showers can be formed. While the storm is gathering the motion is only in the clouds, it is brought into the lower regions by the descent of the rain. Most storms occur in the afternoon, when the sun is in the south or south-west, hence the shadow of the cloud falls north or north-east. The shadow thus formed has a cooling and hence condensing effect on that side, and therefore produces a tendency in the storm to move in that direction, when the rain falls this is enormously increased, and thus the path of the tempest is established without reference to the direction of the wind, if there be any. Various slight circumstances may affect the initial direction, and it is not uncommon to see storms crossing each other at right angles."

Mohr assumes that the electrical phenomena usually accompanying a storm, are caused by the friction of the particles of water against each other, such friction being produced by the rapidly entering masses of air. The motion visible in the clouds is not an effect of the electricity, but rather the cause. The rain is often seen to fall heavily after each flash of lightning, which is explained by supposing the rapid entrance of a cold mass of air, the deposition of water and friction of the particles, thus causing evolution of electricity, visible in the flash a considerable time before the consequent thunder is heard, and long before the rain can fall.

Electrical storms are well known to be more dangerous in winter and spring than in summer, which may be explained by the fact that the quantity of vapourised water is small on the whole in winter, and only considerable near the surface of the earth. Hence condensation and production of a vacuum can only take place here, and hence the ease with which the electricity may pass from the cloud to the earth.

The cooling effect of a storm is explained by the mingling of the colder upper air with the warmer on the surface. When this cooling is considerable, another storm may not be expected, inasmuch as a greater uniformity has been produced in the atmosphere. Another storm will only occur after a continuance of heat. If no cooling effect is observed, it is probable that another storm will occur shortly.

Mohr thus attempts to explain the fluctuations of the barometer by the condensation of water, and as this explanation seems open to question, the passage is given in his own words:—

"A balloon floating over my barometer presses on it as if it were filled with air of the same density as that which surrounds it. A drop of water floating over the barometer presses on it with the same force as an equally small volume of air. When water passes from the state of vapour to that of liquid, it loses almost entirely its action on the barometer. Hence every condensation must cause a lightening of the barometer, the mercury must fall, and not only in the immediate vicinity of the storm but also at a distance, inasmuch as masses of air are drawn away to fill up the vacuum formed at the spot where the storm is raging."

H. C.

ON THE COLOUR OF WATER.

BY W. BEETZ.*

It is only in recent times that explanations based upon actual experiments have been given of the colour of water in the sea, in lakes, and in rivers; it was previously thought sufficient to conceal the entire ignorance of a daily-observed phenomenon by hypothesis. Bunsen was the first to state, and establish experimentally, the simple proposition that "chemically pure water is not, as commonly assumed, colourless, but naturally possesses a blue colour." He observed this coloration on looking at a piece of white porcelain through a column of water two yards long. He explained the brown to black coloration of many waters, especially of North German inland lakes, as arising from an admixture of humus; the green colour of the Swiss lakes, and, still more so, the siliceous springs of Iceland, as arising from the colour of the yellowish base, and of the siliceous sinter surrounding the springs, and which is caused by traces of hydrated oxide of iron. Wittstein, by careful chemical investigations, has quite recently shown that the green colour also derives its origin from organic admixtures. According to him, the less organic substance a water contains, the less does its colour differ from blue. With the increase of organic substances, the blue gradually passes into green, and from this, as the blue is more and more displaced, into brown. Water is softer the nearer it is to brown, and harder the nearer it is to blue; this does not arise from a greater or less quantity of organic substance, but of alkali, on which, again, the proportion of dissolved organic substance depends. This alkali dissolves the organic substance in the form of humic acid. If a water does not contain much humic acid, this is not caused by a want of humic acid in the ground, but by the fact that this ground did not give to the water an adequate quantity of alkaline solvent material.

From these results we may consider the question settled as to why, on chemical principles, some waters are blue, others green, and others brown. I may be permitted to make a few remarks on some physical phenomena which have been observed on coloured waters.

Formerly water was almost universally classed among those bodies which have a different colour in transmitted, to that which they have in reflected light. Newton says, "water reflects the violet, blue, and green rays, but readily transmits the red." Count Xavier de Maistre considers the colour of water to be blue in reflected, and yellowish orange in transmitted light. Arago, that it is blue in reflected, and green in transmitted light. The view that the blue of water only occurs in reflected light is common to all three statements.

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* From the *Phil. Mag.* for September, 1862.

In the experiments which Bunsen made to ascertain the colour of distilled water, transmitted light was alone concerned, and yet he found the colour blue. In order to look through still longer columns of water I used the following apparatus:—A box, the bottom and and sides of which are made of plates of gutta percha, is closed at both ends by parallel plates of very white thin glass. Directly inside these, two similar glass plates are fixed, which are covered with a silver reflecting surface, by Liebig's method. A narrow slit is scratched in the covering at *d* and *d'*. If a pencil of direct sunlight is projected upon slit *d*, this will be reflected several times backward and forward between the two mirrors; if the box is filled with a liquid, the light is compelled to traverse this liquid repeatedly, and it is easy to increase or diminish the length of the layer to be traversed, by altering the angle of incidence. This experiment may be made either objectively or subjectively. If the pencil is allowed to fall into the slit *d*, so that after a certain even number of reflexions it falls directly upon the slit *d'*, it can be caught upon a screen after its emergence. The number of reflexions may be altered by gradually rotating the box. But if the observer uses the illuminated slit *d* as a self-luminous object, and looks through *d'* into the box, he sees, close to one another, a series of narrow subjective pictures of the slit; they are gradually smaller and nearer each other, and correspond to the different numbers of reflexions. In making some experiments, I had, at first, so placed the mirrors that the uncovered glass surfaces were opposite each other. The light must then, at each reflexion, pass twice through the glass plates themselves. If the box contained no liquid, then the image appeared almost white after six to eight reflexions; but still, on comparing the subjective images with one another, it could be seen that each following one had a somewhat yellowish tint. I supposed that this coloration was to be ascribed to the tolerably thick layer of glass which the light had to traverse, and therefore turned the mirrors, which were once more polished on the silvered side. Yet even in this case each following image showed a yellower colour, though in a less degree. The colour must therefore be ascribed to the special colour of the silver, from which part of the light is reflected diffusely. Yet when the polish is good, it is so unimportant that it does not disturb further observation.

If the box is half filled with distilled water and the entire slit *d* illuminated, the lower part of the picture on the receiving plate is seen to be blue, while the upper part remains white. Looking through the slit *d′* at the upper part of the box, the entire range of more and more yellowish pictures is seen; looking through the lower part, each following picture appears of a darker blue, with a very feeble tinge of green. The phenomenon is just the same when water from the deep blue Achensee is poured into the vessel; if this is replaced by water from the Tegernsee, after a few reflexions the images appear of an intense yellowish green (not bluish green), although my box was only 10 inches long, If garden earth is drenched with water, which is allowed to drain off, and this is filtered and mixed, first in small and then in larger quantities, with distilled water, the colour of the images passes first into yellowish green and then steadily into a brown colour, just as was to be expected from Wittstein's experiments. The colours in question in these experiments are also those in transmitted light.

What, then, are the phenomena which have evoked the idea of the dual colour of water?

Newton based his view upon an experiment of Halley. As the latter, on a sunny day, had descended in a diving-bell to a great depth in the water, the upper surface of his hand, which was directly illuminated through the sea-water and through a window in the bell, appeared of a rose-red, but the water below him and the under surface of his hand, which was illuminated by the rays reflected from the lower water, was green. The experiment is manifestly erroneously interpreted. The rays which came from below are clearly not reflected by the water, but transmitted; they are reflected indeed from foreign substances in the water, especially from the sea-bottom. The further distant this is, that is, the deeper the sea at the given place, the deeper will be the colour of the water—deep green when the water has a green, deep blue when it is blue (in transmitted light.) The rays which fell from above into the bell must also show the color of water, but to a much smaller extent, because the layer of water which they traverse is, in any case, much less thick than that which the rays coming from below have traversed. Thus the upper rays brought comparatively more white light than the lower ones; and hence the upper surface of the hand had the complementary colour, that is, rose-red, for the same reason for which, in the blue grotto at Capri, the contrast colour, orange, occurs.

Arago adduces no experiment in support of his view; he only proposes to make one, to which reference will afterwards be made. He introduces his view with the words "the reflected colour of water is blue, the transmitted, as some think, green;" and upon this supposition he bases the explanation of some phenomena. He shows, in particular, why the waves of the blue sea are green. He considers them as water prisms, on one surface of which the white daylight is reflected, sent through the following wave, and thereby made green. But it is easy to see that in the green waves, as well as in the large blue mass of water, it is only a question of transmitted light. On looking at the mirror-like surface of the Achensee in a perfect calm, the colour is seen to change from a deep blue in the middle to a bright green, and thence into a yellowish red. This water, which contains very small quantities of humus salts, colours the light greenish when it only passes through thin layers, and blue when it passes through thicker. This phenomenon has many analogies. Newton says, it must be noticed that in coloured liquids the the colour alters with the thickness. For instance, a red liquid in a conical glass held between the light and the eye appears pale yellow near the bottom, where it is thinnest; somewhat higher, where it is thicker, of a golden yellow; where it is still thicker, red; and where it is thickest, dark red. Hence it must be assumed that such a liquid absorbs the violet and indigo rays very readily, the blue rays with greater difficulty, the green ones with still greater difficulty, and the red ones least of all.

This is just the case with bluish-green sea-water. It absorbs the red rays very easily, the green ones with more difficulty, and the blue ones least of all. Hence when white daylight passes to the bottom through a thin layer of this water, and reflected from this returns to the air, it is feebly green. If on both courses it has traversed great distances, it is blue. It also appears green when it has passed through the moderately thin section of a wave (which it may indeed have reached by reflexion from another wave.)

I spoke just now of the reddish-yellow colour in the almost dry places which has been noticed by so many observers. This colour depends entirely on the nature of the ground. Most frequently it consists of whitish sand, or whitish pebbles. If these were absolutely white, if they reflected colours in a diffused manner to the same extent, the reddish colour would not occur. A new porous clay-cell of a Grove's battery may appear quite white, while, when it is moistened with water, it is of a rusty yellow or flesh-red colour. Hence its surface acquires the property of reflecting red light to a preponderating extent. If, now, the substances which constitute the sea-bottom have the same property, the bottom will appear red in those parts in which it is covered with quite thin layers of water. If the thickness of the layer of water increases, fewer red rays reach the bottom ; the returning rays are again partially absorbed by the water, and thus the red colour is continually disappearing, although the forms of substances lying on the ground can always be distinctly perceived.

Moreover, this red colour is much increased by contrast. In the dry places of the Aar I have often observed that the bright red, which they show, diminishes considerably when they are viewed, not near the beautiful green of the deeper water, but through an isolated tube.

There might seem to be a fact in discordance with the statement, that sea-water in thin layers is green, and blue in thicker ; a white object, for instance an oar, appears of a distinctly pure blue when immersed at even a very inconsiderable depth below the level of the Achensee, while it is of an intense green below the Tegern-or Königsee. The light which impinges upon the white surface of the oar, has had to traverse a much more considerable distance than that from the surface of the water ; it comes from the side through a considerable mass of water, in which it has assumed the characteristic colour of the lake. But if the same white surface is brought near the bank and turned towards it, and is at the same depth as in the former case, it is seen in the Achensee to be of an almost unaltered white, while in the Tegernsee it is always somewhat greenish ; for the colour of the blue water is only perceptible at great distances, that of the green at very small ones.

This surprising strong coloration in consequence of laterally incident light, led me to the proposal which Arago has made, to investigate the true colour of water in transmitted light.

A hollow prism made of glass plates is so brought under water that the horizontal light from the surface is totally reflected from the hypothenuse. Instead of this apparatus, Poggendorff proposed a glass mirror inclined at 45° to the horizon. I happened to have occasion to make a corresponding experiment; I wanted to fill a tinplate tube, which was closed at the ends with glass plates and had a hole in the side, by placing it in a very inclined position, quite under the sea level. When the upper glass plate had the right inclination, in the Tegernsee it reflected in sunny weather an emerald-green light more intense than I have obtained in any other way; in the Achensee, however, a blue light, as if it had passed through concentrated solution of sulphate of copper. Hence Arago's proposal is appropriate; and if he had had an opportunity of carrying it out, he would certainly have given up the notion that water shows different colours in reflected and in transmitted light.

The colour of water alters naturally, when solid particles are suspended in it. By mixing such bodies which, like the above-mentioned constituents of the ground, reflect red light in preference when they are moistened, it may yet appear red; by greater masses of whitish sand which have become heaped up in the lakes during a continuous storm, or which the rivers have worn down from their beds, the water appears clearer than otherwise. Simony observes that the Wolfang and Attersee appear in winter, when they are clearest, of a dark green, but in summer bluish-green or cerulean blue, and he considers this colour as occasioned more especially by the marl and grey sandstone predominant in the débris.

In the previous considerations, the influence of the colour of the sky and of the surrounding neighbourhood has been disregarded. Yet there are many who seek the cause of the colour of water in these circumstances. But these secondary influences must be taken into account along with the chief cause. When the surface of the lake is quite clear, it acts as a mirror. The special phenomena of colour are the more concealed, the more regular reflected light reaches the eye from the place in question; they appear purest where no or but little light is regularly reflected, for example, against a dark rocky background. But if the sea is in motion, the regular reflection always diminishes, and the aspect of the surface is changed by the occurrence of waves in a very complicated manner, depending on the formation of the bank, the direction and intensity of the wind, and similar circumstances, which the mariner can recognize, and even predict from that aspect.

I permit myself a remark as to the place in which the green colour of water arises. The Tegernsee receives its water by several supplies, among which the Weissach and the Rottach are the most considerable. After lengthened dry weather, the bed of the Weissach is quite empty; the pebbles which cover the bottom are quite dry, and almost white. After a time of such weather, I went up the course of the Weissach in order to observe the first water which moistened the ground. This water could have no other origin than the atmosphere. Yet the first quantity, which was sufficient to look through in bending over the bed, immediately appeared green. Hence the humic acid salts must have been already formed in the bed of the river, and are only dissolved by the water; it is not necessary to assume that the springs which fed the rivers must bring an alkaline solution which shall afterwards dissolve the humic acid.

Water, of atmospheric origin, in its purest condition of ice and snow is also blue. The glaciers of the Alps and of Iceland also show this colour when the adjacent waters, which in part arise from the glacier streams, are green. H. and A. von Schlagintweit estimate the colour of glacier-ice in the crevices as being equal to the mixed colour shown by a colour circle on which 74·9 parts of white, 24-3 of cobalt blue, and 0-8 part of green were painted. Osann saw that the light in a hole in the mountain snow about two feet deep was blue, and believed that this colour was due to the blue colour of the air, which has a deeper blue in the upper than in the under layers, and he therefore thinks that the blue colour of glacier-ice is heightened by that of the air in those higher regions. But the experiment on which he depends succeeds with freshly fallen snow on the plain as well as above the snow-line. The other colour depends on the colour of the small crystals of ice which the light repeatedly reflected backwards and forwards in such a small hole must traverse. Green ice can only be caused by the freezing of green lakes and rivers; the atmospheric fall, and the compression of the high snow can only give rise to the formation of blue ice.

Erlangen, December, 1861.

REVIEWS.

A Manual of Geology, treating of the Principles of the Science, with Special Reference to American Geological History. By James D. Dana, M.A., LL.D. Philadelphia: Theodore Bliss & Co. 1863.

The appearance of this much desired volume is gratifying, in more respects than one, to those interested in the progress of Natural Science. Not only does the work supply, and supply thoroughly, a long-felt want; but its publication may be looked upon, we hope, as strong presumptive evidence that the serious and protracted illness of Professor Dana, by which the issue of the work was for some time retarded, has now happily passed away. Until the appearance of this treatise, we had no work at all approaching to a complete or exhaustive character, on American geology. Popular compilations, and some of undoubted merit, like the Manual of Professor Hitchcock for example, have, it is true, appeared from time to time; but the illustrations and materials of these are largely drawn from European sources; and whilst certain departments of the subject may be fully elaborated, others are comparatively untouched, or, at least, are far from representing in a satisfactory manner the present aspect of the science. In Professor Dana's Manual, these objections will be sought for in vain. The work is thoroughly American in its character, without being exclusively so; as ample reference is made to the geology and physical characteristics of the globe generally. Its pages are copiously illustrated with figures of American fossils, with maps of interesting geological regions, and with sections and views of rock structures as exhibited on this continent. As regards completeness, moreover, the work may be relied upon in all respects, as a faithful exponent of the present state of our knowledge on the subjects brought under review. In its first division, under the head of *Physiographic Geology,* we are presented with a general survey of the surface-features of the Earth, embracing the distribution of land and water, the physical characters of the great continents and oceanic basins, the more important atmospheric phenomena, and other kindred topics. The second part, entitled *Lithological Geology,* is devoted to a special consideration of the mineral constituents, varieties, structural details, &c., of rock masses, as illustrated more especially by American types. The third and principal subdivision of the volume, *Historical Geology*, contains a detailed exposition of the geological ages and epochs, from the far distant Azoic period to the present or historic time; and it exhibits in this connexion, many important generalizations respecting the life-forms, and the various climatic, geographical, and other features, of the eras thus discussed. To this succeeds a section on *Dynamical Geology*, or review of the various forces now in action in modifying the surface and general conditions of the globe.

Such is a brief synopsis of the contents of this important volume. On account of the peculiar nature of the work, its constant reference to back pages and sections, and the necessarily paragraphic form in which much of its information is laid before the reader, it is not easy to obtain an extract for quotation, more especially from the purely geological portions, in which its able character can be fairly shewn. The subjoined passages (selected partly on account of their general interest) may serve, however, to shew the uninitiated reader that a treatise on geology comprises something more than a mere dry description of barren rocks and stones:

Criteria of Rank among Animals.

(1.) Under any type, *water-species are inferior to land-species:* as the Seals to the terrestrial Carnivores; the water-articulates or Worms and Crustaceans to land-articulates or Spiders and Insects.

(2.) *Species of a tribe bearing some of the characteristics of an inferior tribe or class are inferior species, and conversely.*—Thus, Amphibians show their inferiority to True Reptiles in the young having gills like Fishes; the early Thecodont Reptiles, inferiority to the later in having biconcave vertebræ, like Fishes; the Marsupials and Edentates, inferiority to other Mammals in having the sacrum consisting of only two united vertebræ, as in most Reptiles. On the contrary, the Dinosaurs show their superiority to other Saurians in having the sacrum made of five (or six) vertebræ, as in the higher Mammals.

(3.) *As a species in development passes through successive stages of progress, relative grade in inferior species may often be determined by comparing their structures with these embryonic stages.*—As a many jointed larve without any distinction of thorax and abdomen is the young state of an Insect, therefore Myriapods or Centipedes, which have the same general form, are inferior to Insects. As a young living Gar has a vertebrated caudal lobe (making an accessory upper lobe to the tail), which it loses on becoming adult, therefore the older Ganoids with vertebrated tails (or heterocercal) are inferior to the latter in which the tails are not vertebrated (or are homocercal). As the young of a Frog (a tadpole) has the tail and form of a Salamandrian, therefore the Salamandrians are inferior to Frogs. As the number of segments in the young of Insects often exceeds much that of the adult, therefore species of adult animals in which there is an excessive number of segments (beyond the typical number) have in this a mark of inferiority; and thus the Phyllopods and Trilobites among Crustaceans bear marks of inferiority, the typical number of segments in the abdomen of a Crustacean being but seven, and in the whole body twenty-one,—each pair of members corresponding to *one*, commencing with the eyes as the anterior.

Professor Agassiz has brought out and illustrated in his writings each of the above Criteria.

(4.) *Species having the largest number of distinct segments in the posterior part of the body, or having the body posteriorly prolonged, are the inferior among those under any type.*—Shrimps and Lobsters are thus inferior to Crabs; Centipedes, to Insects; Salamandrians, or tailed Batrachians, to the Frogs or tailless Batrachians; Snakes, to Lizards; the Ganoids with vertebrated tails, to those with non-vertebrated. It does not follow on this principle that Frogs, although tailless, are superior to Lizards; for they are of different types of structure.

(5.) *Species having the anterior part of the body most compacted or condensed in arrangement, or having the largest part of the body contributing to the functions of the head-extremity, are the superior, other things being equal.*—Thus, Man stands at the head of all Vertebrates in having only the posterior limbs required for locomotion, the *anterior having higher uses;* and also in having the head most compacted in structure and brought into the least compass consistent with the amount of brain. In the same manner, the Carnivores among the large Mammals (Megasthenes) are superior to the Herbivores, the anterior limbs not having locomotion as their sole use, and the head being more compacted and condensed for the size of brain. The highest Crabs, the Triangular or Maioids, are superior in the same manner to the lower, and far more to the Lobster tribe and other Macrourans; descending in grade from the higher Crabs, the outer mouth-organs become more and more separated from the mouth, and finally, in many Macrourans, they have the form of feet, thus passing from the head-series to the foot-series. Insects are on this principle superior as a class to Crustaceans, although of so much less size.

Condensation anteriorly and abbreviation posteriorly is the law of all progress in embryonic development, and also of relative rank among species of related groups.

Relation of the History of Life to the Physical History of the Globe

1. *The plan of progress was determined with reference to the last age, with all its diversities of climate, continental surfaces and oceans, as its era of fullest exhibition.*

2. *The progress in climate and other conditions involved a concurrent progress from the inferior living species to the superior.*—The existence of a long marine era, through the Silurian and part of the Devonian ages, admitted only of the existence of marine life. Hence the dominant type of the Silurian was the Molluscan, which, with the Radiate, is eminently marine. In addition, there were marine Articulates and marine plants; and when the Vertebrates began it was with marine species, the Fishes. Thus the prevalence of waters involved inferiority of species. The increase of land, gradual purification of the atmosphere, and cooling of the globe, prepared the way for the higher species.

It is probable that the oceanic waters were also in an impure state compared with the present, from containing an excess of salts of lime; and this also involved the existing of inferior species,—such as Crinoids, Corals, and Mollusks, a very large proportion of whose weight is in calcareous material. The removal of this excess of lime from the waters produced limestone strata, purified the waters, and fitted the oceans for other species,

The great prevalence, in the Primordial, of Lingulæ (whose shells contain a large amount of phosphate of lime) is further evidence of the greater density of the waters, and seems to indicate the presence of an excess of phosphates.

3. *The progress in climate and in the condition of the atmosphere and waters involved a localization of tribes in time, or chronographically, just as they are now localized by climate over the earth's surface, or geographically.*—Tribes were made for a special climate or condition of the globe; and when this climate or condition had been passed in the earth's progress, the tribes no longer existed. The culmination of the Reptilian and Molluscan types in the Reptilian age, or of Trilobites and Brachiopods in Palæozoic time, are examples. The former when instituted had those special relations to climate that made the Reptilian age the era of their culmination; just as now palms and bananas reach their perfection only in the equatorial zone; figs in the tropical; myrtles and laurels, in the sub-tropical; evergreen trees, in the warm-temperate; ordinary deciduous trees, in the cold-temperate; and pines, in the sub-arctic. As there are now these zones on going from the equator to the poles, so there were successive eras passed over from the Silurian—the period of universal warm temperature—to the present age of a frigid arctic, and a mean temperature of 58° to 60° F. Climate may not have been the only cause; but it was one, and of great importance. The Crustacean type is one of those which have culminated in the age of Man; and this accords with the fact that its highest species—the Maioids, or Triangular Crabs—are now most numerous and of the highest rank in the colder temperate zone. It was made to reach its maximum in a cold climate, and therefore in the existing age.

No species survived through all time, and few through two successive periods; The oldest now existing began in the Middle Tertiary, and these were only Invertebrates. The oldest quadruped dates no farther back than the Post-tertiary.

But two genera range through the whole series of ages from the first or Potsdam epoch,—*Lingula* and *Discina*,—enough to manifest the oneness of system from the beginning. There was in general a changing of genera with the successive periods. Even *tribes* wholly disappeared from age to age, as the world outgrew them. Of Trilobites, 500 species once lived, of the Ammonite group, 900 species, all of which are extinct; the Nautilus tribe, 450; three or four species are all that exist. Of Ganoid fishes, 700 species have been discovered; the tribe is now nearly extinct. Thus, the old has passed away as the new has come in. Remains of nearly 40,000 animal species have been gathered from the rocks, all of which are extinct; and, considering how few of the whole number have become fossilized, this can hardly be one-tenth of the number that have existed and are gone. 2,500 extinct species of plants have been found,—

which cannot be over a twentieth of all that have covered the earth in its former ages.

4. *The extermination of species was in general due to catastrophes, while the extinction of tribes or higher groups may have been a consequence of secular changes in the condition of the climate, atmosphere, or waters.*—The extermination of species here alluded to, and some of the kinds of catastrophes which caused them, are briefly considered on p. 398.

5. With regard to *the Organization of Species*, Geology suggests no theory of natural forces. It is right for science to search out Nature's methods, and strive to employ her forces—organic or inorganic—in the effort, vain though it prove, to derive thence new living species. The study of fossils has given no aid in this direction. It has brought to light no facts sustaining a theory that derives species from others, either by a system of evolution, or by a system of variations of living individuals, and bears strongly against both hypotheses. There are no lineal series through creation corresponding to such methods of development. Instead of gradations from Mollusks or Articulates to the lower Fishes, and so on upward, the Fish-type commences near its summit-level, or rather between the level of the typical fish and that of a higher class of Vertebrates. Were either of these plans the system in nature, examples of the blending of species would be common through all the classes, high and low; and North America would afford them as successive stages between the old Elephant or Mastodon and earlier species, and so throughout the various tribes of life, animal and vegetable. But, in fact, appearances suggesting the idea of such shadings among species are exceedingly rare,—wonderfully so, considering that Palæontology has only the imperfect stony secretions of animals to study out, which sometimes afford insufficient distinctions even when perfect and from living species. Under any scheme of development of species from species, the system of life, after ages of progress, would have become a blended mass,—the temple of nature fused over its surface and throughout its structure. The study of the past has opened to view no such result.

Geology appears to bring us directly before the Creator; and, while opening to us the methods through which the forces of nature have accomplished His purpose,—while proving that there has been a plan glorious in its scheme and perfect in system, progressing through unmeasured ages and looking ever towards man and a spiritual end,—it leads to no other solution of the great problem of creation, whether of kinds of matter or of species of life, than this:—DEUS FECIT.

In closing this brief notice of Professor Dana's excellent treatise, we may observe that the author appears to have carefully avoided, throughout, the adoption of any one-sided views. In all debatable cases, the opposite sides of the question are equally discussed: a method of treatment which adds much to the value of the work.

E. J. C.

Nelson's Atlas of the World: constructed from the most recent authorities; with divisions and measurements in English miles. By Thomas Nelson, Jun., and Thomas Davies, C. E.

Nelson's Wall Maps.

Nelson's Family Maps. London and Edinburgh: T. Nelson & Sons.

Under the direction of one of the most enterprising of British publishers, we have here produced an atlas and series of large and small maps, embracing some of the most useful improvements that practical sagacity and experience have recently contributed to the facilities of education. The points in which they differ from all previous maps are not more admirably adapted to remove the difficulties they cope with, than they are simple. Like so much else that is of the most practical utility, the wonder is that such adjuncts to our school maps were never thought of by Geographers till now.

The projection of the maps is a combination of the conical development, with that by which Flamstead successfully aimed at not only making equal spaces on the map represent equal portions of the earth's surface, but also at admitting of correct measurements being made parallel to and perpendicular to the equator. In the combined system here adopted, the parallels of latitude are represented by concentric segments of circles as in the conical development; while, as in that of Flamstead, the degrees of longtitude are accurately laid off on each parallel, and the meridians are drawn through these points, forming curved lines convex towards the centre meridian. By this arrangement, while it possesses all the accuracy of Flamstead's projection in the measurements of areas, and of distances parallel to, and perpendicular to the parallels of latitude, the diagonal measurements are more accurate.

The next practical difficulty dealt with is the process resulting from the application of astronomical mensuration to the science of Geography. The ordinary mode of stating the geographical position of Toronto is: latitude 43 degrees, 39 minutes, North; longitude 79 degrees, 21 minutes, West. But this scientific language requires for all ordinary uses, to be translated into the speech of common life. Comparatively few can form any distinct idea of the relative distances and positions of places on the earth's surface by their longitude and latitude. Impressed with this conviction, Mr. Thomas Nelson, one of the authors of the new atlas, conceived the happy idea of applying to geography a system of mensuration by English miles; and thus by the employment of the language of common life, making maps more readily intelligible, and more suited for general use. From this have resulted the following new and distinctive features:—1st. All the maps, with the exception of the hemispheres, are laid off in squares of a specific number of one thousand miles, and these are again subdivided into squares of one hundred miles each. For example, the map of Europe forms a square of four thousand English miles, subdivided into smaller measured squares; and the map of England embraces a square of four hundred miles. sub-divided into squares of one hundred miles. In ordinary atlases the scale varies so much, that the young student is in danger of adopting the impression that England is about the same size as Russia, or the United States. In the new atlas this is effectually obviated. Russia, and Norway and Sweden, as the largest countries of Europe, exceeding in area one thousand square miles, are laid off on maps of the definite number of measured squares. All the other countries of Europe, and also the Canadas, Cape Colony, New South Wales, &c., are mapped on the standard scale of one thousand miles square. Each map moreover, embraces all within the measured area, so that the student has always the relative size and distances brought vividly to his mind; and the comparative extent of separate countries cannot be over-looked.

By this simple process, the youngest child can ascertain at once how far Edinburgh is from London, or Toronto from Quebec. By the old process, the student would ascertain that Quebec is in latitude 46 degrees, 49 minutes, North; longitude 71 degrees, 16 minutes, West; by the New Atlas, in addition to this he ascertains at a glance that it is about 3,050 miles west of London; about 320 miles south of London; and 3,330 north of the equator. He can also ascertain with ease its approximate distance from any desired point. Thus by the maps, with the additional assistance of a copious index and table of distances, the student has at his command relative geographical positions in this form: Rome, for example, lies 540 miles east of London, and 663 miles south of it. Its direct distance is 889 miles.

The maps retain the ordinary degrees of latitude and longitude, so that whatever novel features they present are additions, not substitutes for the old system and terms of measurement. But on the hemispheres the lines of latitude are drawn at intervals of 1000 miles north and south of London, and the lines of longitude at the same intervals measured on the parallel of London. In addition to those, another class of circles drawn from London as a centre, show the distance by thousands of miles from that point; and on the other maps the lines of hundred or thousand square miles, are accompanied by the measured intervals of latitude and longitude.

We have thus specified some of the more obvious improvements introduced by Mr. Nelson into the system of Geographical instruction by maps. To indicate the difference of time at each point on the earth's surface, as determined by the number of degrees through which the sun travels westward every hour, the Mercator's projection is marked off in parallels of longitude at intervals of 15 degrees, each marked with the hour westward or eastward of London. On turning to an Atlas chiefly used in our Canadian Schools to ascertain how the same information was there conveyed, we were amused to find the clumsy and almost ludicrous device of a page covered with rows of clock-dials, with the hands of each pointing to a different time, and printed underneath each the name of some city: London, Rome, Washington, Toronto, Nankin, Jerusalem, &c. The contrast between the science of the one and the unpractical empiricism of the other, could scarcely be surpassed.

The Wall Maps are coloured so as to exhibit the details in bold contrast; and the execution of the whole is admirable. The great additional labour and cost involved in the construction and engraving of Maps in which ellipses have to be used instead of circles, have unquestionably tempted Geographers to adhere to the common projection, notwithstanding some notorious defects. The projection generally adopted is not, indeed, the true globular one, but a modification of that projection, in which economy of construction is secured at the expense of accuracy. In the new system of projection and the other novel features of the maps we now refer to, they appeal to all who are interested in education, by improvements suggested by sound practical common sense, and a successful application of intelligent experience to surmount difficulties felt by every young student in mastering that useful part of education, which is indicated in most higher school prospectuses, under the name of "The use of the Globes." At the end of such a course of training, it would be an instructive test to ascertain how many are able to translate the ordinary Geographical definitions of latitude and longitude, into a distinct idea of the relative distances and positions of any two places on the Earth's surface.

That we have not over-estimated the value of the Atlas and Maps, here referred to, is proved by the fact that they have been specially selected for commendation by Sir Roderick Murchison in his Address before the Royal Geographical Society, in which he remarked:—

"Nelson's Atlas is an excellent and carefully executed work, of that class which reflects so much credit on our Scottish Geographers, and is an evidence of the great and increasing interest taken by the public in Geography"; and he specially refers to the novel feature of the distances and measurements given in English miles. A no less high authority, the distinguished astronomer, Sir John Herschel, thus speaks of them: "I have seldom or never seen Maps more beautifully executed. The idea of dividing each map into squares of a hundred and a thousand miles, and of inserting circles indicating the distances from London, is a happy and useful one for popular Maps." In those for Canada we might perhaps desire an additional series of circles, showing the distances from Ottawa, or some other point on our Western Hemisphere; but we have said enough to indicate our sincere belief that Mr. Nelson has produced an Atlas and Maps with such strong claims for preference by teachers, that it will constitute an important element of educational progress when they supersede all others in our Common and Grammar Schools.

D. W.

Annals of the Astronomical Observatory of Harvard College. Vol. III. Account of the great Comet of 1858. By G. P. Bond, Director of the Observatory of Harvard College. Cambridge: Welch, Bigelow, and Company, Printers to the University, 1862.

Our readers need not be told that a comet is yet an unsolved problem of the Universe. It is true that there has been no doubt as to the nature of the orbits of these strange visitants since Newton, applying his wonderful analysis to that of 1680, compelled it to confess that it was describing a conic section round the sun, like the members of that family party which constitute the solar system, among whom it had intruded. In earlier days, they had been supposed to be only meteors existing in the earth's atmosphere, but Tycho Brahé put an end to this notion, by shewing that their orbits lay beyond the moon. Kepler, who wrote a treatise on them, remarkable, as all his works are, for poetic imaginings and ingenious conjecture, was apparently puzzled by the complication of the geometrical conditions of their motion, and was reduced in despair to propose straight lines as the best he could make of their paths. The true curve was, as we have said, demonstrated by Newton, and when, a few years later, Halley had found that the comet, which bears his name, was moving in an ellipse, and confidently predicted its return at a stated period, nothing was wanting to assign to the wanderers their character as material bodies subject to the power of gravitation like common things. Yet though they were thus seen to be under the influence of Father Sol, and to obey the same laws as his recognised children the planets, and though some of them even conform so far as to move about him in re-entering orbits, there are peculiarities which prove them to be foreign to this family, alike in their origin and persistence. For while all the members of the planetary system move around the sun nearly in the same plane, all in ellipses of small eccentricity or nearly circles, and all in the same direction, comets on the contrary violate all these laws; their orbits are of all sorts of eccentricity, most of them parabolas, some even hyperbolas; their planes are inclined at all angles to the ecliptic, and their motion is frequently retrograde instead of direct. Laplace has calculated the mean position of the orbital planes of a great number, and has found it to lie with reference to the ecliptic at the angle at which it ought to lie, if there be no determining cause to one position rather than another. An acute remark of Herschel's may here be noted in connection with the fact that the periodic comets have mostly their motion direct, and their planes not widely different from the ecliptic, a result which ought to be expected, for a comet in a parabolic orbit near the ecliptic, if its motion were *direct*, would be likely to be thrown by the disturbing action of the planets into an elliptic one, while if it were *retrograde*, the orbit would be converted into a hyperbola, and the comet would pass away from our system never to return to it. We may then consider a comet to be a body moving in the extra-planetary spaces in a straight line with uniform velocity, till its path approaches near enough to the sun to be sensibly affected by his attraction, and the comet then obeying the principle of universal gravitation is drawn into a conic, the nature of which depends on its initial velocity, in some cases merely passing once round the sun and again going off into space, in others moving round him in a periodic orbit which may or may not be permanent according as its motion takes it into the neighbourhood of other bodies which disturb it from this orbit, and perhaps (as we shall see presently) there may be a something in the commonly-called "free" space itself which has an effect. The number of comets whose observation has been recorded amounts to nearly a thousand, and in recent times the average is said to be about five a year, but this is only a small portion of the number even of those which come into our system, (for it is only of such that we have cognisance), not to speak of those outside of it. Many there must have been too faint to be visible at all; many of them not visible from our situation at the time of their approach to the sun. It must have been a startling apparition during the total eclipse of 62, A.D., when a huge swordlike comet was seen close to the sun, not seen before or after. Some few have been bright enough to be seen in broad daylight, but not many can bear the light even of the full moon, and, in more than one instance, after approaching the sun in considerable brilliancy and being lost for a time in his glare, the comet has never reappeared on the other side of him, though closely watched for. Very capricious too are even the periodic ones in their splendor; as that of 1759 which, from its decaying lustre and diminished tail at each successive appearance, deluded Laplace into a conjecture that it might be undergoing a process of condensation and solidification which would fit it to become an orderly member of the planetary group, a world in the act of manufacture under our eyes; and this would have been a triumph for the "nebular Hypothesis." Unfortunately, in 1835 it came round as bright as ever, spreading its tail with more than its pristine sweep, and the Nebular had one more disappointment to put up with.

The days are past when

> "Some pilgrim comet, on his way
> To visit distant shrines of light,"

could throw the nations into panic as a forerunner of plague, war, and pestilence, could drive emperors from their thrones and be anathematised by Popes, but not less at the present day is the excitement, though of a more pleasurable kind, caused by these strange visitors. "There is, beyond question," says Herschel, "some profound secret and mystery of nature concerned in the phenomenon of their tails." To fathom this mystery, to trace the history and hidden cause of the wonderful changes and disturbance that a comet undergoes, is now and has for years been earnestly attempted by astronomers, and no sooner does a comet swim within our ken, than it is watched by hundreds of eager telescopes which dog it with unrelaxing attention through every step of its visible course. Nor can a better proof of the keenness of this pursuit be given than is furnished by the magnificent volume whose title is cited at the head of these pages. We have here brought within one grasp the whole of the observations made upon the great comet of 1858, from the first glimpse caught of it by Donati at Florence, on June 2nd, when it showed itself as "a little nebulosity having a diameter of about three minutes, and with the illumination equally diffused throughout its surface," tracing night by night its gradual development and extinction, till it vanished from the gaze of Maclear at the Cape of Good Hope, on Feb. 26, 1859, when its diameter had become less than one minute. Many circumstances were combined to render the observing of this comet of peculiar value—its position relative to the earth got rid to a great extent of the effects of foreshortening, and an unusual continuance of fine weather on both sides of the Atlantic, and the absence of moonlight at the most critical periods, rendered available more opportunities than are commonly afforded. Professor Bond, of whose ability America may well be proud, and who has added lustre to the reputation which his lamented father had well earned for the observatory of Harvard, has admirably performed the duty he proposed to himself, by collecting all the scattered mass of information to be found in the reports of the numerous astronomers from all parts of the globe (no less than 84 different observers are quoted); it adds to the value of his work that he has quoted them each in their own language and words (though a lazy reader may wish he had translated here and there, especially as Danish and Swedish are not given every body to know), and still more that by classifying the phenomena he has enabled us to consider each separately, without extraneous distraction, and has further made the necessary calculations and reductions with his well-known skill and accuracy ; it is only justice to Professor Bond to add that his own observations at Harvard form the most valuable portion of the whole series. Nor can we refrain from giving our humble approbation of the thorough manner in which the volume has been sent to press, of the fine typography and extremely beautiful engravings ; and when we add that the whole expense has been defrayed by the private liberality of some leading citizens of Boston, our readers will join us in admiration of such noble liberality displayed during this dark epoch of their unhappy country.

A comet may be divided into four parts ; First, the *nucleus*, a star-like point, sometimes a disc ; Second, the *coma* or wig, a luminous haze surrounding the nucleus, and generally increasing in intensity towards the centre :—these two constituting the *head ;* Third, the *tail*, directed from the sun and widening as it recedes, brightest at the edges, its outline lost in mist at the end: and to these three, we must now add the *veil*, first observed in the present comet, a dim band of light surrounding the head and tail, sharply distinct from them by the faintness of its illumination. These characteristics, however, do not mark every comet. Many of them have no trace of tail: one, at least, has been recorded whose head entirely disappeared, leaving a long tail as its only representative: others have had more than one tail,—that of 1744 had six, "spread out like the sticks of a fan,"—in several, an additional tail has been thrown out *towards* the sun,—in other cases the twin tails have been inclined at angles from 18° to 120°, and sometimes there have been streamers darted out like those of the Aurora: in the present comet, two such were seen; one of them starting from the head and touching the tail proper, running in a nearly straight line far beyond it, and the other shooting out from the tail itself about one third of its length from the head, and running off at a different angle from the former. Again with regard to the nucleus, it has been totally wanting sometimes, and both it and the planet-like disc shewn in other cases have resolved themselves under a high power of the telescope into nebulosity; on the other hand, the head has in two or three cases appeared to consist of a number of such stellar points; Halley's comet in 1835 was seen by Sir John Herschel at the Cape to have formed a new nucleus after its perihelion passage, and this nucleus had a diminutive coma and tail within and distinct from the original head, a miniature comet within a comet; the like phenomena having also being long ago recorded by Kepler. But the most wonderful vagary of this kind was that actually seen in Biela's comet, which beneath the observer's eyes, split itself into two distinct comets, each having its own appendages complete, and travelling side by side the rest of their course with a chain of light uniting them. After undergoing various alternations of relative brightness, the old one appeared at length to obliterate its companion, and threw out three tails as if in token of victory, but the distance between them was great enough to render it probable they would henceforward move as independent comets, and their return has been anxiously looked for, though as yet (we believe) without success.

It is, however, in the tail that the great mystery lies. We have mentioned that the tail (speaking loosely,) is always directed from the sun: that is, it follows the comet in its descent to the sun, and precedes it in its recess. Now if the tail be a material body, acted on only by the gravitating attraction of the sun, and the mutual attraction of its parts; that it should thus sweep round, unbroken (to use Herschel's phrase) like a rigid rod, and this as in one case more than a hundred millions of miles long through a semicircle in less than two days, is absolutely impossible, being in defiance of the principle of gravitation and the common laws of motion. Before, however, entering upon the discussion of any explanatory hypothesis, it will be well to examine somewhat minutely the actual phenomena manifested in the production of this strange appendage.

Generally a comet is first seen as a telescopic object in the shape o a round nebulous body of a pale color, sometimes of equable illumination throughout, in other cases having its intensity increasing towards the centre, but without appearance of tail. As it approaches the sun, it begins to brighten and swell out slightly towards him, while on the opposite side the tail begins to run out in a luminous band of the breadth of the head. As it comes nearer and nearer the sun, much commotion is seen to ensue in its head, indicated by rapid changes of brilliancy and alternations of apparent density; the tail now surrounding the head on the side towards the sun, and branching off in the opposite direction round the head into two streamers. These apparently are separated for some distance from the head, forming a bifurcation of the tail with a dark space interposed, but presently coalesce, widening out as they recede, diminishing in brightness towards their ends, and less illuminated towards the median line between them. These streamers, however, are not straight but curved, the foremost streamer being convex towards the direction to which the comet is moving, and the hinder one being still more curved in the same direction, the former being also much the brighter of the two, and its outline more sharply defined and for a longer distance, so that in this state they are not inaptly compared by several of the observers to a quill pen or a bird's wing. A better notion would be gained of this conformation by a glance at the beautiful figures in this volume than by any verbal description. The axis or median line of these streamers is at starting directed *from* the sun, but not exactly in the line joining the sun and comet, generally being deviated backwards from the direction of the comet's motion. In the comet of 1557, the deviation amounted to 20°, if the observation can be trusted. In this of 1858, the observations may be satisfied by a constant deviation of from 4° to 6°, the axis being supposed to be in the plane of the orbit, but Prof. Bond finds this latter supposition inconsistent with the observations, and we may add that this result of a *constant* deviation being throughout preserved, is *a priori* very unlikely. Some remarkable irregularities presented themselves, however, in this comet. Shortly after the first appearance of the tail, the curvature it assumed was in the direction *opposite* to that above stated and which it afterwards had, and at the same time the *following* branch was brighter than the preceding one; observations so abnormal that one would have been inclined to refer them to a delusion of the observers, had they not been strangely confirmed by a recurrence of the same phenomenon, not long before the disappearance of the tail as the comet was going away. There was also noticed for some time a change in the curvature of the outlines, both branches being bent inwards about the middle of their lengths, making the tail somewhat of a lozenge shape, or like a willow-leaf. In connection with this may be noted the irregular termination of the inner branch as it gradually faded into a shapeless mass of light. We will here quote the observations themselves.

Oct. 8, POWELL at MADRAS.—"Outline of envelope ragged, the tail reaching a little beyond α Coronæ Borealis. On the lower side the light shades off almost imperceptibly; on the upper, though ragged, it terminates comparatively abruptly. The darkness down the envelope scarcely so clear as before. Nucleus about as bright as Mars or α Lyræ. The shape of the envelope bears a resemblance to a pen, being narrow at the head, and after a short space suddenly spreading on the lower side like the feather of a quill."

Oct. 8, WEBB at TRETIRE, ENG.—"The general impression of this (the under) side of the tail was that of spreading out like a feather, as compared with the more definite aspect of the convex edge."

Oct. 10, Same observer.—"The curvature appeared regular as far as a line joining α Coronæ and ζ Herculis, or perhaps a little farther; thence a fainter ray of considerable breadth was deflected at a large angle, perhaps 60°, as far as the stars of *Quadrans Muralis.* This portion was very feeble, but certain, *and looked quite like a scattered and abandoned vapor.*"

And special note may be taken of the following:

Oct. 8, SECCHI at the COLLEGIO ROMANO.—"Si conserva pure all' osservatorio un disegno della cometa come era visibile ad occhio nudo, ove si ebbe cura di far rilevare la forma curva dell' estremità della coda, e quella specie di materia sparsa che l' accompagnava, irregolarmente diffusa che si potrebbe credere affatto useita dalla sfera d' attrazione della cometa e perduta. Questa materia era sempre visibile dalla parte della curvatura interiore della coda la quale riusciva perciò mal terminata, mentre la esteriore era benissimo decisa."

The two secondary tails or streamers in this comet have been already noticed; they were much fainter than the real tail, whereas in that of 1861 (1), the streamer was decidedly brightest. A curious bulging out of the head into a sort of large horn, was observed in the early stage of the comet on the side towards the sun, at an angle of some forty degrees or so; an appearance so singular that its reality might have been doubted had it not been confirmed by its recurrence towards the end of the comet's course, testified from an opposite part of the world.

Another peculiarity seen for the first time, we believe, in this comet was the so-called "columnar structure" of the tail, the broad end of it being cut up by parallel dark bands, the direction of which did not appear to be referrible to either the axis of the tail or the sun. The two branches of the tail, coalescing after running some length, left between them a less illuminated space, to which the name of the "dark zone" has been given, varying much at intervals in extent and never sharply outlined; but within this was noted a "dark canal," proceeding direct from the nucleus with its breadth continued uniform, and traceable for a good way even into the brighter part of the dark zone. It is described as being at its origin "almost black," and might tempt us to fancy it an actual shadow of the nucleus, if it were not that its position, deviating some degrees from the sun, forbad the supposition. Of the outer faint "veil," or nebulous envelope dimly surrounding the head and tail, and sharp in its outer edge, little is to be said except that it was not symmetrically placed with regard to the nucleus, and was so delicate an object that it escaped the attention of nearly all the observers.* But the most important result of all, and one for which Prof. Bond may claim the lion's share of credit, relates to the knowledge he has been enabled to gain of the formation of the tail itself.

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* There do not appear to have been observed any of those pulsations or coruscations of an auroral character, which are recorded in other cases,—as for instance when Kepler tells us that the tail of the comet of 1607 would in the twinkling of an eye become very large, and in several other cases where the tail exhibited undulations as if it had been blown by the wind, and in more recent times, the great one of 1843 shot out in one evening a new tail inclined at 18° to the other and *twice as long*, never seen again. The only notice we remark is by Mr. Spalding at Selby, Eng., who says:—

"A sudden and momentary emanation from the nucleus was remarked. At first it was supposed to be due to atmospheric causes; but from its recurring in precisely the same form, the author felt convinced that it was really attributable to a change in the nucleus."

"Appearances of a similar nature continued to be observed during the visibility of the comet."

It is odd that no other observer saw them in this instance, but we think there can be no doubt of the reality of such momentary pulsations existing, and that Olbers is entirely astray when he assigns their origin to atmospheric causes.

Sir William Herschel was the first to notice in the comet of 1811, that the tail seemed to be only a prolongation of part of the coma which was separated from the head by a dark interval, and was led to the inference that the tail was in effect a hollow envelope enclosing the head at its upper part, and having a space between it and the head occupied by some dark atmosphere or non-luminous gas, thus satisfactorily accounting for the brightness of the apparent edges and the obscurity of the central part or dark zone. In the comet of 1835, this inference was confirmed by the experience of Bessel and others, with the addition that this envelope was connected with the head by a conical jet of light, an *aigrette lumineuse* or luminous sector, which proceeded in a fan-like shape from the nucleus toward the sun and then bending back on both sides seemed to send a flow of luminous matter into the tail. This jet was by no means stable in form; sometimes single, sometimes split up into several; now thin, now broad, but always brighter at its start from the nucleus and gradually melting into the haze of the coma. Bessel added the curious fact that the axis of this aigrette was in a state of rapid and continuous oscillation about an axis perpendicular to the plane of the orbit, never deviating far from its mean position, nearly directed towards the sun. This has not been observed in recent cases; the comet of 1858 showed no symptoms of such a movement. So far then we should infer that the tail was formed by a stream of luminous matter projected in a conical jet from the nucleus towards the sun, and then meeting with some repulsive agency, was checked, and turning back flowed round the sides in a continuous stream with ever-widening section. Sir John Herschel very aptly compares it to the trail that follows the smoker against a brisk wind. But the admirable examination of our 1858 comet by Prof. Bond leads us to modify this conclusion. He has shown that the tail is not thus formed by a continuous jet, but is due to a series of envelopes which are successively thrown off, like skull-caps, from the head. No less than five of these were identified and consecutively watched, (in that of 1861, there were no less than eleven) and so well did Prof. Bond become acquainted with the habits of his patient, that he was able to predict the recurrence of the event.

"Oct. 8. The nucleus to-night is decidedly brighter than on the 6th, and is preparing to throw off a new envelope."

"Oct 9. A new envelope, E., has been thrown off, as predicted last evening."

The normal process seems to be a brightening of the nucleus, then an envelope in contact with it; the nucleus becomes fainter, and the envelope spreads, becomes "mottled" or "curdled" with intermittent jets and lumps of luminosity, its form a sharply curved outline towards the sun and running round more than a semi-circle into two cusps behind the nucleus. Gradually it rises and the dark space intervenes between it and the head, broken however sometimes by the jets; its light fades as it gets higher, till it begins to crumble away at its vertex, and gradually disappears down to its cusps which are the last to melt into the general haze. The interval between the disengagement of the successive envelopes varied from 4 to 8 days, and the velocity of each diminished as they expanded, so that they closed on each other in the higher regions, and the puzzling circumstance of a decided dark spot occurring in one of them, was of use not only in identifying that envelope, but in showing that there was no rotation round the axis in it. Curiously enough, the dark spot was repeated in the same relative position in the following envelope.* It is not

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* We quote the following from Prof. Bond's summary of results.—

"At first they (the envelopes) presented a variety of aspects, but as they expanded they tended to conform with a normal type, the light becoming more evenly disposed and the outline more symmetrical. For a few days the surface was closed on the side opposite the sun, although here and there penetrated by streams rising into the tail, principally from the cusps on either side. As it expanded, the discharge became general, but was always most considerable from the outside, thus forming the asymptotic branches below the nucleus. The curve on the side towards the sun in a completely formed envelope was very nearly circular for 60° to 80° on either side of the axis. This was originally the brightest and best defined region, but it was also the first to fade away, the material being evidently transferred to the outlines below the parallel of the nucleus, which remained in the sight long alter the upper portions had disappeared, and finally driven off into the tail. The process of dissipation furnishes a satisfactory explanation of the branches of the tail, which are simply the continuation of the older envelopes merged together and undistinguishable from each other excepting near the nucleus. In this view the dark hollow of the axis represents the region not fully supplied from the envelopes, while they retained their closed or partially closed surfaces. . . . . After reference to the dark arcs interposed between adjoining envelopes and the bright marginal rims of the latter, the subject of the dark and bright spots on their surface is taken up. Several results of considerable importance have been derived from the discussion. Among them are,—1st. A degree of permanence in the internal distribution of the substance of the envelopes retained for a long interval after their ejection from the nucleus. 2nd. That their diversified aspect, especially the isolation of bright masses, cannot be explained as a mere optical effect produced by the intersection or separation of streams of luminous matter passing out continually from the nucleus into the tail. 3rd. The nearly permanent direction maintained by the spots relatively to the axis of the tail proves that there was no sensible rotation of the envelopes, excepting in a sense always preserving an unaltered aspect towards the sun. 4th. That there was no sensible oscillatory improbable that the structure previously mentioned as described by Bessel may be only an imperfect observation of those detailed by Prof. Bond, as we notice that the descriptions and even the figures of many of the observers tally very closely with those of Bessel, while at the very same time Prof. Bond's figures so plainly shew the envelope-formation. Indeed so very unlike are the drawings of the comet, made by different observers to represent its condition at the same time, that it is hard, while looking at the Plate in which they are put side by side, to credit that they are intended to represent the same object. Of course the blame of this must be laid to atmospheric causes, and the inferiority of the telescopes to the great Equatorial at Harvard.

We may note that Prof. Bond has calculated the nature of the curve followed by the outline of the head and envelopes towards the sun, and finds it to be a catenary, and the enveloping surface would be thus generated by the revolution of a catenary (not necessarily of constant directrix) about its axis. Prof. Bond could not decide whether the sections perpendicular to the axis were circles, and observes that he finds no evidence to show that they are not. We should rather remark on the extreme *à priori* improbability that they should be so.

Before proceeding to the physical hypotheses which have been set forth, there are two points worth consideration. First, can a comet be said to be in any sense a solid or opaque body? Second, is its light self-derived, or merely reflected like that of the planets? With regard to the first of these, Newton remarks—(we quote the quaint language of his first translator): "Now if one reflects upon the orbit describ'd, and duly considers the appearance of this comet, he will be easily satisfied that the bodies of comets are solid, compact, fixt and durable, like the bodies of the planets. For if they were nothing else but the vapours or exhalations of the earth, of the sun, and other planets, [rather :—vapours or earthy exhalations of the sun and planets,] the comet in its passage by the neighbourhood of the sun, would have been immediately dissipated. For......the heat, which dry earth on the comet while in its perihelion, might have conceived from the rays of the sun, was about 2000 times greater than the heat

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motion of the nature of that seen in Halley's Comet, as described by Bessel, 5th. The repetition of spots and rays, and other similar peculiarities of structure in successive envelopes, in nearly the same direction, strongly indicates that the nucleus itself constantly maintained the same aspect towards the sun, without sensible rotation other than is implied in this condition, and without oscillation."

of red-hot iron.* But by so fierce a heat, vapours and exhalations, and every volatile matter must have been immediately consumed and dissipated."

At the present day we should draw a conclusion from the same fact directly opposite to Newton's. We can hardly conceive that a solid body would *not* be vaporised by so fierce a heat. The question of opacity would of course be settled at once by the occultation of a star behind the nucleus, and there seem to have been plenty of cases where this would have been seen if it had occurred, yet Bessel says that he cannot satisfy himself that any observed passage of a comet over a star has been really central. Whether, however, there be any solid nucleus or not, the tail and head must be of extreme tenuity, for stars have been repeatedly seen through all parts, in some cases with brilliancy unaltered, in others, diminished, (as was to be expected, partly from the perspective effect, partly from the absorption of light by the passage,) and in a few even increased. This last result is so odd that one would like to disbelieve it, but the evidence seems too strong, for Relhuber in a comet of 1846 says that a star of the 8th magnitude (just invisible to the naked eye) when it was centrally covered by the comet, became very considerably brighter and was judged to be equivalent to one of the 6th, in which case it could have been distinctly seen without a telescope.† An opaque body also, if not self-luminous or not surrounded by a luminous atmosphere, would present phases like the planets, and onthis point again the evidence is conflicting, but the advantage lies decidedly on the negative side.

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* This remarkable calculation—almost a divination for the time it was made—has been repeatedly but imperfectly quoted, and almost always misunderstood. Arago has been evidently misled, by one of these imperfect references, to make an objection to it which is altogether mistaken. The following is the original passage:—"Est enim calor solis ut radiorum densitas, hoc est, reciproce ut quadratum distantiæ locorum a sole. Ideoque cum distantia cometis a centro solis Decemb. 8, ubi in perihelio versabatur esset ad distantiam terræ a centro solis ut 6 ad 1000 circiter, calor solis apud cometam eo tempore erat ad calorem solis æstivi apud nos ut 1000000 ad 36, seu 28000 ad 1. Sed calor aquœ ebullientis est quasi triplo major quam calor quem terra arida concipit ad astivum solem, ut expertus sum, et calor ferri candentis (si recte conjector) quasi triplo vel quadruplo major quam calor aquæ ebullientis; ideoque calor, quem terra arida apud cometam in perihelio versantem ex radiis solaribus concipere posset quasi 2000 vicibus major quam calor ferri candentis."

† Quoted in Hind's *Comets*. We add the following from the present volume, "When it [Arcturus] had entered well within the margin of the tail, a dark notch was formed, cutting out a portion of the tail round the star; and as the star got farther in, this became a dark aureola surrounding the star, and in diameter equal to about one tenth of the line of transit. This continued until the star reached the middle; at this part there is a broad dark line which extends from the nucleus to a distance considerably above the point where the star crossed. When Arcturus arrived here, this dark space was perfect up to the star, but on the other side the white light of the tail appeared to come quite up to the star; in short, as the bright part of the tail had been darkened in the vicinity of the star, the dark part was brightened, at least so much of it as was on the side farthest from the nucleus. I saw the notch again on the opposite side previous to emersion, and then lost it by clouds. The effects I have described are, doubtless, optical, and the notch and aureola evidently due to the bright light of this star; the effect on the dark central part is not so easy to explain."

Is the light of the comet its own? The very sudden changes of brilliancy would seem to answer this question in the affirmative, if it were not that they may be equally well supposed to arise from sudden changes of density in the substance of the comet which might change its capacity for reflection; and the same consideration negatives also the argument that may be drawn from the observed illumination at different distances not conforming to the arithmetical ratio it should follow, if due wholly to the sun. On the other hand, the light from the comets has been found in some cases to be polarised, proving that some portion at least of it has undergone reflection; but in other cases (notably in that of 1843) no trace of polarisation could be detected, and it is just to infer that these comets at least were in the condition of an incandescent gas. And again, as Bessel has remarked, if the substance of the comet be capable of reflecting light, it must also be capable of refracting it, and this would be evidenced by the change of position in a star seen through it. A very favorable opportunity of testing this enabled him to assert that there was no such refraction, or at least none large enough to be sensible to our most refined observations. And indeed such a refraction could hardly be expected to be sensible, when we consider how excessively refined the density of the cometic substance must be to occupy such immense spaces with so small a mass,— so small indeed that no disturbance has ever been detected as produced by them in the motions of the least of the planetary system, as in the case of Lexell's comet which paid a visit to Jupiter, and so far from deranging his satellites, was itself diverted from its proper orbit and sent off to wander anew in distant regions, never having been seen among us since. On the whole it seems probable that there is no solid substance in a comet, but that it is a mass of extremely rarified incandescent vapor, reflecting also the light of the sun, and thus shining both by its own and by borrowed light.

The older philosophers were content to say that the particles of a comet's tail ascended from the sun by virtue of their inherent levity, just as some bodies fell to the earth by virtue of their inherent gravity. Another hypothesis made the tail to be only the effect of light in passing through the nebulosity of the head, like the beam of sunlight admitted through a small hole into a darkened chamber, and viewed transversely. Kepler conceived that the substance of the comet was broken up by the impact of the solar rays, and that the light particles were carried away by the impulse, forming the tail, while the denser ones stayed behind and made the head; and this was an ingenious conjecture, the Solar rays being imagined as something shot out from the sun like arrows. Newton was the first to advance a better founded theory. He supposed the existence of an ether pervading space or an atmosphere of the sun, and that the parts of this in the vicinity of the comet, becoming rarified by the heat which it acquired from its approach to the sun, ascended amid the cooler and denser atmosphere, carrying off with it the luminous particles of the comet, just as we see in our atmosphere a current of heated air ascend, carrying up with it the smoke of a fire. This hypothesis goes a long way toward satisfactorily explaining the prominent phenomena concerned, such as the form of the tail, its curvature, the deviation of its axis, the brightness of the forward edge, but it fails to account for the more unusual ones, such as the secondary tails. And perhaps the strongest objection to it is that which lies on the surface, namely, the absence of proof that there exists such a *vera causa* as the assumed ether. It is true that observations on Encke's comet establish a gradual diminution of its periodic time, an effect which would be produced by the resistance of such an ether, (and indeed such an effect was predicted by Newton himself, whose sagacity nothing seems to have escaped, for the comet of 1680, a prediction not fulfilled however,) but it cannot be held established that this is the very cause which produces the said effect. For the calculation of the retardation in this single case would only enable us to ascertain the law of resistance of the ether assumed to exist, and it would be necessary to show that this law satisfies also the retardations in other observed cases, before we can assert the truth of our hypothesis, and no such other case has yet been found, which fact is itself almost conclusive against the hypothesis.

Bessel, reasoning from the appearances presented in his observation of Halley's comet, has developed another theory which is waiting the test of facts for acceptance or rejection. The conical jet, or *aigrette lumineuse*, had a rapid oscillatory movement from one side to the other of the sun's radius-vector. According to Bessel this can not be explained as an effect ot the attraction of the sun. For although the attraction might cause an oscillation (corresponding to the libration of the moon), the period of it would be very long, while the observed duration was very short. It is necessary therefore to infer that the sun exerts on the comet a force distinct from that of attraction, capable of producing this rotation: that is, a polar force which tends to direct one radius of the comet towards the sun, and the opposite radius in a contrary direction. Such a force as magnetism for instance. Granting the existence of this force, the explanation of the oscillatory movement is obvious. Our readers may like to see Bessel's own words:—"Le mouvement oscillatoire de l'aigrette antour du rayon vecteur ne peut pas s'expliquer par l'attraction du Soleil, il faut supposer que le Soleil exerce en outre sur la comète une force de rotation; de plus, il est nécessaire que le noyau de la comète participe à ce mouvement. . . . . Il est nécessaire d'admettre une force polaire que tende à diriger un des rayons de la comète vers le Soleil, et le rayon opposé dans le sens contraire; il n'y a aucune raison pour rejeter *a priori* une pareille force. Le magnetisme sur la Terre nous offre l'exemple d' une force analogue, quoiqu' il ne soit pas encore prouvé qu' elle se rapporte au Soleil [it has been since]; si cela était, on en pourra voir l'effet dans la prècession des équinoxes [?]. Unc fois cette force admise, il est facile d' expliquer le mouvement oscillatoire de l'aigrette; la dureè des oscillations dépend de la grandeur de cette force, et leur amplitude d'une constante relative au mouvement initial des molécules."

Undoubtedly if the sun exerts any other force than that of attraction, it must be a force of the kind Bessel calls "polar," for the action summed throughout the whole system must be zero. The analogy drawn by him between this supposed force and the terrestrial magnetism seems quite imperfect, nor can we understand how Bessel could conceive that the polarity induced in the particles of the earth by magnetism would affect the position of the earth's axis, so as to make itself apparent in the precession of the equinoxes. Certainly we ought to be very sure of our facts before we have resort to this extreme hypothesis, and we have already mentioned that Prof. Bond not only did not discover any such oscillation in the '58 comet, but makes it tolerably evident that a less searching scrutiny might have led to an assertion of its existence. The only rotation which Prof. Bond detected—rather by way of inference than direct observation—was that of the nucleus, so as to present the same face always to the sun, as the moon does to the earth, which would seem to involve the conclusion that a rotation had been originally impressed upon or possessed by the comet exactly adapted to its orbital motion, which is so wildly improbable that we may be glad to escape from it at any price.

To explain the emission of the particles in a cone towards the sun and their turning back to form the tail, Bessel invents a *repulsive* force exerted by the sun on particles projected from the nucleus with velocities such that the component perpendicular to the radius-vector is the same for all. Such a repulsive force might be due (he says) to electricity, magnetism, or to a non-resistant ether pervading space, on which latter supposition the theory becomes very like Newton's. He is thus enabled to explain the form and curvature of the tail. For the manner in which he conceives the action of this force and its necessary contrary, we must leave him to speak for himself*, merely adding that for the case of two tails, he finds it necessary to admit that this repulsive force must have two different values for different portions of the luminous matter, and so for six tails we should have six such forces, and so on without limit. On the whole Bessel's theory has not received much confirmation from recent observations, and there still lies behind, both against it and Newton's, the overpowering difficulty of the rapid sweep of the tail round the sun, requiring, on any hypothesis of material emissions from the head, such enormous forces, and employing velocities almost inconceivably great. We believe all such hypotheses to be untenable; but is it possible to suggest any other? Let us imagine a mass of nebulous matter, left to the attraction only of its own particles; it will arrange itself into a sphere, the strata increasing in density towards the centre. Now let the sun attract it, and it will assume an ovoid shape, the longer axis pointing to the sun. Suppose it now in motion round the sun, and by a tidal action the fluid shape will change so as still to turn its longer axis towards him. Now add the effect of heat as it nears the sun, vastly expanding its dimensions; there will be condensations and rarefactions in abundance, and the stratification will become complicated enough to meet most contingencies, but the median line will deviate from the radius vector in the backward direction. Now add a luminous action of some sort excited by the sun, (say "electricity," remembering certain resemblances in the comet's behaviour to that of the Aurora,) and instantaneously exerted in the directions of least resistance. Perhaps by this time we may have come to something not unlike Herschel's "negative shadow," impressed, however, not on the "luminiferous ether" but on the atmosphere of the comet itself, and if we take into account the possibility of the existence of several centres of condensation instead of only one, the subsidary phenomena may not be impossible to explain. It seems certain that the body of a comet is not confined merely to that part of it which is visible to us,—the discovery of the new "veil" may assure us of this,—and the diminution of volume of the head as it approaches, with the subsequent increase as it recedes from the sun suggests (as Newton remarked) an evaporation or transformation into non-illuminated gas of the nebulous substance, which is again condensed into the head.

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* Je regarde le mouvement oscillatoire de l'aigrette lumineuse de la comète de Halley comme un effet de la mème force qui lance dans des directions opposées les particules sorties du noyau parallèlement au rayon vecteur. Voici comment je suppose que cette force agisse. Toute action d'un corps sur un autre peut être divisèe en deux parties, dont l'une s'exerce également sur toutes les particules de ce dernier, et dont l'autre se compose des différentes actions exercées sur diverses parties. Lorsque les corps sont très éloignés l'un de l'autre, et que leur action est trés faible, e' est la première partie qui devient d'abord sensible, à mesure que la distance diminue; la seconde ne peut avoir de valeur appréciable que plus tard. Ainsi, lorsqu' une comète se rapproche du Soleil après en avoir éte très èloignée, on s'aperçoit d'abord de l'action gènérale qu' il exerce sur toutes ses parties. Je suppose que cette action consiste en une volatilisation des particules qui en outre soient polarisées de telle sorte a être repoussées par le soleil. La seconde partie de l'action peut avoir pour effet la polarisation de la comète elle-même, et une émission particuliere de matière lumineuse dans la direction du Soleil. La partie de la surface d'ou sort l'aigrette lumineuse a une polarisation telle, qu' elle tend à etre attirée vers le Soleil; et par conséquent, les particules qui la composent ayant la méme polarisation, tendent aussi à se rapprocher du Soleil. Mais ces particules se meuvent dans une espace rempli d'une matière polarisée en sens contraire, qui tend à se reproduire constamment, aussi les deux polarisations contraires se neutraliseront, et les particules qui composent l'aigrette prendront la propriété opposée à celle qu' elles avaient précédemment, d' autant plus qu' elles se sont plus éloignées du rayon de la cométe.

What is the "final cause" of comets, or what useful end do they serve in the plan of creation? Not to mention the moral effects they have exerted in past ages on the ignorance of mankind, nor the forgotten theory of Whiston, that a comet was the instrument of God's wrath in the Noachian deluge, by so near an approach that the impulse of the resulting tide in the inner sphere of water was great enough to fracture the solid envelope of the earth, nor the strange conjecture of Buffon that the planets were bits of the sun chipped off by the dash of comets against him, nor that of Olbers that the asteroids were the fragments of a large planet broken up by collision with a comet, nor other groundless fancies of the same kind, we can assert that one good service has been rendered by them to philosophy, by enabling us to ascertain from their perturbations the masses of the planets, and perhaps also by showing that the nebulous matter of extra-planetary space is like common matter in its subjection to the law of gravitation. Newton, however, with a fertility of imagination which recalls to us Dr. Johnson's saying:—"I am persuaded that had Sir Isaac Newton applied to poetry, he would have made a very fine epic poem,"—has suggested that the light and heat of the sun may be renewed and sustained by the comets which, moving in ever-contracting orbits, would ultimately fall in and be absorbed by him, and this theory has been revived in our days with elaborate circumstance by Prof. W. Thompson. Not only the sun but other fixed stars may share this benefit, and thus might be accounted for the sudden and irregular apparition of brilliant stars in the heavens, not known before. Nay, even the planets may be benefited in this way, for, says Newton :—

"The tails therefore that rise in the perihelion positions of the comets will go along with their heads into far remote parts, and together with the heads will either return again from thence to us, after a long course of years ; or rather, will be there rarefied, and by degrees quite vanish away. . . For all vapour in those free spaces is in a perpetual state of rarefaction and dilatation. . . And it is not unlikely, but that the vapour, thus perpetually rarefied and dilated, may be at last dissipated, and scattered through the whole heavens, and by little and little be attracted towards the planets by its gravity, and mixed with their atmosphere. For as the seas are absolutely necessary to the constitution of our earth, that from them, the Sun, by its heat, may exhale a sufficient quantity of vapours, which being gathered together into clouds, may drop down in rain for watering of the earth, and for the production and nourishment of vegetables ; or being condensed with cold on the tops of mountains, (as some philosophers with reason judge) may run down in springs and rivers, so for the conservation of the seas and fluids of the planets, comets seem to be required, that from their exhalations and vapours condensed, the wastes of the planetary fluids spent upon vegetation and putrefaction, and converted into dry earth, may be continually supplied and made up. For all vegetables entirely derive their growths from fluids, and afterwards in great measure are turned into dry earth by putrefaction ; and a sort of slime is always found to settle at the bottom of putrified fluids. And hence it is, that the bulk of the solid earth is continually increased, and the fluids, if they are not supplied from without, must be in a continual decrease, and quite fail at last I suspect moreover, that it is chiefly from comets that spirit comes, which is indeed the smallest, but most subtle and useful part of our air, and so much required to sustain the life of all things with us." And in another place, "The vapours which arise from the sun, the fixed stars, and the tails of the comets, may meet at last with, and fall into the atmospheres of the planets by their gravity ; and there be condensed and turned into water and humid spirits, and from thence by a slow heat pass gradually into the form of salts, and sulphurs, and tincture, and mud, and clay, and sand, and stones, and coral, and other terrestial substances."

We must refer to Arago for a grave discussion of the following questions: *Do Comets sensibly influence the weather?* Epicures know the "vintage of the comet-year," and who has not read of the

> .... Comet, which with torrid heat,
> And vapour as the Libyan air adust,
> Began to parch that temperate clime.

Were the dry fogs of 1783 *and* 1831, *matter detatched from a comet's tail? Has the moon ever come into collision with a comet? Has she herself formerly been a comet?* and if so, what has she done with her wig? *What would become of us if the Earth were to be carried away as a satellite by a comet?* In which case Arago holds it not proven that the human race would necessarily perish from thermometric changes, and this is consolatory. *Has the axis of the Earth been shifted by the shock of a comet, and did not such a shock produce the depression of the large area in Central Asia?* Lastly, *what would be the effects of a collision between our Earth and a comet?* In answer, listen to Laplace!—If the earth dashed against it, so that the motion in space should be stopped, all things not adhering to the earth's surface, animals, water, &c., would fly off it at a rate of 72000 miles an hour. Even if the shock did not wholly destroy the earth's velocity, still the axis of rotation would be altered, the seas would leave their beds and rush towards the new equator; in this universal deluge, animal and man would in great part perish, or would be destroyed by the violence of the blow; entire species annihilated; all the courses of human industry confounded, &c., &c. A horrible picture to contemplate! True,—we are comforted by the great virtue of the "if," and by the calculation that the odds are 281 millions to 1 against the happening of the event. So, when the legendary militia-man with shut eyes fired his musket against the barn-door, the chances were millions to one against his hitting any assigned point; nevertheless, *some* point was hit in spite of the enormous odds in its case; and when we know that Biela's Comet cut the Earth's path when she was only one month absent from that point, it must be confessed that the comet has come very close to us nothwithstanding our theory of probabilities.

We have seen that Newton regards with complacency the admixture of a comet's tall with our atmosphere. Herschel on the other hand thinks such a rencontre would be "not unattended with danger." Probably in such matters it will be well to follow the advice of the celebrated philosopher of Astracan—that "the best way to ascertain what the result of such an event can possibly be, will be to wait till the event actually happens."

We conclude with our most hearty thanks to Prof. Bond for his splendid work, and trust to see still more important services rendered by him in a similar examination of the great Comet of 1861.

J. B. C.

SCIENTIFIC AND LITERARY NOTES.

ETHNOLOGY AND ARCHÆOLOGY.

ARTIFICIAL OCCIPITAL FLATTENING OF ANCIENT CRANIA.

The following correspondence is inserted in the Journal at the request of Dr. Joseph Barnard Davis, M.R.C.S., Eng., F.S.A., who has responded to the invitation, contained in the third letter of the series, to reply to the previous letter and paper on the above subject: by enclosing to Dr. Wilson his letter, (No. 4.), with the following request: "I shall feel obliged by your placing it in the hands of the Editor of the *Canadian Journal*, to be printed with our letters to the *Athenæum*, which I also enclose, and any additional remarks you may be pleased to make."

No. 1. *To the Editor of the Athenæum.*

University College, Toronto, Aug. 14th, 1862.

In the last number of the *Natural History Review*, for July, Dr. Joseph Barnard Davis contributes a paper 'On Distortions in the Crania of the Ancient Britons,' the point of chief importance in which is to establish that the peculiar flatness in the occipital region of ancient British crania was produced by some artificial process analogous to that effected by the American Indian cradle-board in infancy. It happens, unfortunately, that, in the belief that Dr. Davis recognized my prior origination of this idea, I have spoken of him in a forthcoming work, 'Prehistoric Man,' as giving the weight of his concurrent testimony to my previously-published opinions. This is not the only case in which I experience the difficulties of a colonial author, with the Atlantic intervening between him and his publisher, and making that false when published which was true when penned. As the sheets of my work are through the press, and the question has some scientific bearings of general interest, perhaps you will favour me with a brief space in the columns of the *Athenæum* for necessary explanation.

In a paper 'On the Supposed Prevalence of One Cranial Type throughout the American Aborigines,' which was read for me by my late brother, Dr. George Wilson, before the Ethnological Section of the British Association, at Dublin, in 1857 and printed in the *Edinburgh Philosophical Journal* for the following

January, as well as in the *Canadian Journal* (Nov., 1857), I remarked, when referring to a striking example of the vertical occiput in an Indian skull found in Canada,—"I think it extremely probable that further investigation will tend to the conclusion that the vertical or flattened occiput, instead of being a typical characteristic, pertains entirely to the class of artificial modifications of the natural cranium familiar to the American ethnologist alike in the disclosures of ancient graves, and in the customs of widely separated living tribes. In this I am further confirmed by the remark of Dr. Morton, in reference to the Peruvian crania;" and, after quoting him in reference to the unsymmetrical conformation common to the Indian occiput, which, he says, "is sometimes, no doubt, increased by the manner in which the child is placed in the cradle," the paper thus proceeds: "To this Dr. Morton subsequently added, in describing an unsymmetrical Mexican skull, 'I had almost omitted the remark, that this irregularity of form is common in, *and peculiar to, American crania.*' The latter remark, however, is too wide a generalization. I have repeatedly noticed the like unsymmetrical characteristics in the brachycephalic crania of the Scotch barrows; and it has occurred to my mind, on more than one occasion, whether such may not furnish an indication of some partial compression, dependent, it may be, on the mode of nurture in infancy, having tended, in their case also, if not to produce, to exaggerate the short longitudinal diameter, which constitutes one of their most remarkable characteristics." Such was the hint I gave of an important feature affecting the question of primitive British archæology, the full working out of which I reserved for the revisal of my '*Prehistoric Annals of Scotland.*' I readily accept the consequences of my delay in publishing more extended views on the subject, and recognise Dr. Davis's claims to all that is novel in his paper; but as he omits all reference to my published views, while referring to various Continental authorities, and produces the idea as an original discovery, the following extract from one of his contributions to the '*Crania Britannica* will best set forth my reasons, not only for claiming priority of publication, but for crediting Dr. Davis with the adoption of the idea as one first suggested in my paper on the American cranial type. In Decade III. of the '*Crania Britannica*,' when describing an ancient skull from Caedegai Barrow, Denbighshire (pl. 23, p. 3), he remarks:—"Our description of those from Juniper Green, Lesmurdie and Newbigging has made known an unusual and rather abrupt flattening in the occipital region, which we consider to have been the work of art at an early period of life. * * * Among the American races in general there is so marked a flatness in the occipital region, that Prof. Morton was induced to regard it as one of the few typical characteristics of the skull belonging to the American nations, and spreading from one end of the continent to the other. This position, which is, no doubt, founded on truth, must be allowed to be liable to numerous exceptions. * * * Prof. Daniel Wilson, of Toronto, in an able paper, has expressed a reasonable doubt whether this occipital flatness, or great vertical diameter, be properly a universal character of the American races, and has supported his argument by observations made upon crania disinterred in Canada. He has also given expression to a query, which the examination of skulls remarkable for vertical diameter and flatness of occiput naturally induces, whether the American races may not owe these cranial characters, in some measure at least, to artificial distortion? That nature accorded to many of them a brachycephalic skull, and also that this feature is so marked as to be regarded as a typical character among the majority of the races of the western continent, may be admitted. Still, art has been frequently, almost generally, called in to heighten this conformation in a smaller or greater degree; and it is by no means improbable that its influence may be perceived among the aboriginal crania of the British Isles, especially in this greater or less occipital flatness, which is frequently unsymmetrical." ('*Cran. Britann.*,' Decade III., Sept., 1858.)

The mention here made by Dr. Davis of my views on the American artificially-modified cranium is referred in his own foot-note to the *Canadian Journal* (Nov., 1857). The reader of the '*Crania Britannica*' might be apt to suppose that the concluding remarks about British aboriginal crania were entirely new; but any one who takes the trouble of turning to the original article quoted above will find that I had considered the question in its bearings on "the brachycephalic crania of the Scottish barrows" on the same page: hence my assumption that Dr. Davis gave the weight of his testimony to my previously-published views. A highly-interesting chapter, by Dr. Davis, in the First Decade of the '*Crania Britannica*' is devoted to discussing both natural and artificial distortions of the skull; and there, it may be presumed, such an idea would have found place had it been entertained by the writer at that earlier date. He now refers to the Juniper Green, Lesmurdie and Newbigging skulls as illustrating the artificially flattened occiput. But it is only in the description of the last of these, in the same Decade III., published in 1858, that a "slight distorting process" during life is hinted at. In the description accompanying the view of the Lesmurdie skull, in the earlier published Decade, "posthumous distortion" and, in that of Juniper Green "posthumous deformation," are alone referred to.

The Juniper Green skull, as will be seen from the description of it in the '*Crania Britannica*,' was recovered by myself in 1851, when I was collecting materials for a work on Scottish ethnology, supplementary to my '*Prehistoric Annals of Scotland*,' then just published; but which my departure for Canada put a stop to. The skull was carried home in my hand a distance of some miles, and its flattened vertical occiput specially attracted my attention, and formed a subject of conversation on the way with my friend, Mr. Robert Chambers. My opinions were based on the conclusion that its peculiar form could not be assigned to "posthumous deformation," as Dr. Davis suggests in his description, because the skull, when originally found, lay in a stone cist, well fitted and covered with a large stone slab, so that it could not have been subjected to the slightest posthumous compression. It also struck me, on first perusing the description of another skull from a barrow at Codford, in Wiltshire, in the same earlier Decade II., that Dr. Davis had overlooked the very element then recognized by me as a probable source of certain peculiar forms of British crania. The Codford barrow skull is no less strikingly marked in its vertical occiput, and in its short longitudinal, as compared with its vertical, diameter. This, accordingly, is just one of the cases to which I referred as probably "furnishing an indication of some partial compression, dependent, it may be, on the mode of nurture in infancy, having tended, if not to produce, to exaggerate the short longitudinal diameter, which constitutes one of its most remarkable characteristics." But what does Dr. Davis say of it? He treats it as an altogether natural, though exceptional, form, thus :—"The circumstances of such a decidedly brachycephalic cranium occurring amongst the ancient British series should arrest the attention. It shows the latitude of form or variety among any given set of features, but still far from allowing of the withdrawal of the skull from the race to which it belongs, and without by any means wholly overshadowing the ethnical characters appertaining to that race." These remarks occur in Decade II., on the page immediately preceding the description of the Juniper Green skull. When I first read them, with my opinions already formed as to the probable artificial origin of the vertical occiput, they attracted my attention as erroneous. I do not think any reader can have guessed from them that Dr. Davis had already adopted for himself the opinion "that the parieto-occipital flatness was produced by some artificial process."

It has afforded me peculiar pleasure, both before and since I left Scotland, to forward, by any means in my power, the valuable labours of Dr. Thurnam and Dr. Davis in the '*Crania Britannica*,' as a truly national work. I trust, therefore, I need not disclaim any unfriendly spirit in making this explanation, forced on me by being already committed to a statement now liable to misconstruction in sheets which, though unpublished, are already through the press. In a friendly review notice of Decade III, in the *Canadian Journal* for March, 1859, I have said, "In Dr. Davis's latter remark on aboriginal British crania, he adopts observations on the subject which occur in the article in this journal," &c. Possibly this escaped his notice.

Placed as I am at some disadvantage, in relation to literary privileges, from my residence so far from the centres of Science and Literature, I shall esteem myself highly favoured by your courtesy if you can afford space for this communication in the *Athenæum*.

DANIEL WILSON.

No. 2. *To the Editor of the Athenæum.*

Shelton, Staffs., Sept. 22, 1862.

I beg that I may be allowed the favour of a few words of explanation in reference to the letter of Prof. Daniel Wilson in your last publication, which seems to invite my reply.

In the first place, I wish to say explicitly that I regret not having referred in my "Note" in the *Natural History Review* to Dr. Wilson's remarks in the *Canadian Journal* of November, 1857, which contain his surmises of what I take to be the *rationale* of the matter. This is a sin of omission, for which I must apologise. It would have been easy to have referred to Dr. Wilson's "idea," and it would, at the same time, have afforded me a confirmatory authority for the view I have taken—a view which, to say the least, craniologists seem not to be prepared to admit. This omission was an oversight, resulting from lapse of memory alone.

The quotation given by Dr. Wilson from my description of the Caedegai skull in the '*Crania Britannica*,' to show that I was *cognizant* of his previous "hint," must surely *prove more than this.* For although it was only a "hint" or "idea," as Dr. Wilson justly describes it, yet the quotation itself shows that I *recognized* him as the enunciator of it. It may be that the reference of the idea to him was not so explicit as it might have been; but it was just the kind of general reference that most writers would have made in the case of a surmise. If, in truth, it were in Dr. Wilson's mind more than an idea, and he was convinced ever since the discovery of the Juniper Green skull in 1851 that the appearance in question was artificial, I had no means of being aware of this, and no knowledge of it whatever, as he had not anywhere published such a "settled conviction." Dr. Wilson is correct in his supposition that his "friendly review notice of Decade III. of the '*Crania Britannica*'" in the *Canadian Journal* of March, 1859, *had escaped my notice.* I was not aware of its existence; and if it contain a further extension of Dr. Wilson's idea, that I am at present wholly ignorant of. Possibly, when Dr. Wilson knows this, it may go far to excuse the omission he complains of. Allowing the greatest weight and importance to Dr. Wilson's previous hints, I believe the theory of the artificial flattening of the occiput is not received, which it certainly might have been, if we were to suppose the date of 1851 as the period of Dr. Wilson's conviction, and that of 1857 as the distinct enunciation of this theory. The fact that it was announced as an idea only, accounts for the small attention it has received, not merely from myself, but from others also. Having experienced much of Dr. Wilson's friendly aid and encouragement in the '*Crania Britannica*,'—in truth, it was he who suggested the title of the book itself,—I hope I shall not be misunderstood when I say, that nothing could be farther from my intention than to do him an injustice.

Secondly, as to my own claims in referring these occipital flattenings to what I believe, with Dr. Wilson, is their true cause. On learning Dr. Wilson's "idea" in 1857 or 1858, I was not at all satisfied. Within a year, I had an opportunity of examining about fifty ancient British skulls in the Bateman Museum for other purposes. I took this occasion to inquire into a peculiarity I had observed before—viz., a flat surface, extending over the posterior parts of the parietals and the upper portion of the occipital—the "parieto-occipital flatness" so often alluded to in the '*Crania Britannica*.' I made notes of all the skulls in which this flatness prevailed, and observed that it occurred in *children* as well as adults, and that sometimes it was accompanied with a *posthumous* flattening, with which, however, it did not coincide, but was distinct. Thus it was by taking the parieto-occipital flatness as the basis of my operations—a view wholly new to Dr. Wilson, I believe—that I was led to deduce what I consider to be the true *rationale* of all these deformations. The next step was the receiving a North American Indian skull, with unsymmetrical parieto-occipital flattening, and the inference that the deformation was, in both cases, owing to the same cause—*i. e*,nursing on the cradle-board. Then came the difficulty of comprising the parieto-occipital and the ordinarily flattened occiput of Dr, Wilson in the same category, which seems to me to be explained by the shelf on the cradle-board being placed at different angles by different mothers.

I fear the history of such a discovery can be of little interest; but it seems necessary to give it, in order to show that, although I have not the slightest wish to deprive Dr. Wilson of the origin of the "idea," this idea proved of small moment in deducing the view I now entertain. Still, Dr. Wilson is justly entitled to the priority of its enunciation, and also to the credit of having led my mind to investigate the subject, if really and truly his "hint" was present to my mind in the inquiry—a point upon which I am so uncertain as not to be able to give any direct testimony. All I can say is, that I do not know whether I availed myself of this "hint" or not. It seems most probable that I did not, as my investigation commenced from a different point—viz., parieto-occipital flatness. But, whether or not, it seems to me of small import, as I have not the least desire to deny to Dr. Wilson the credit of the priority of the "idea."

Whether the remark in Dr. Gosse's 'Essai sur les Déformations Artificielles du Crâne," 1855, p. 74, which I have quoted in the "Note," be an indication that the idea had previously occurred to some one else or not, I cannot tell, as he gives no further explanation. Again, in the late Mr. Bateman's 'Ten Years' Diggings,' under the date of discovery, 1851, the year in which Dr. Wilson's attention appears first to have been called to the subject, an ancient British skull is described in these words: "The occiput flattened as if by artificial means during life" (181 T. p. 273). When the observation was made there is now no means of knowing; but it is so pointed as to lead to the query, whether the idea of the true explanation may not have occurred to others as well as to Dr. Wilson even quite as early as to himself?

Whether Dr. Wilson may still be able to quote me, as he says he has intended to do, as confirming the view he announced, must rest with his own judgment. I do not see any impediment to his doing so If he shall please to add, that my investigations had a different point of departure, and yet arrived at the same conclusion, I believe he may make me of use in contributing to the establishment of his views.

I trust that there is nothing in the tone or terms of this communication which can be otherwise than agreeable to Dr. Wilson. If there be, let me say beforehand, to prevent a misunderstanding I should deplore, that it was not intended, and that I gladly retract it.

J. Barnard Davis.

No. 3. *To the Editor of the Athenæum.*

"University College, Toronto, Dec. 2, 1862.

"In the *Athenæum* of Sept. 20th, a letter of mine appeared, in which I laid claim to priority of publication on the subject of artificially-flattened occipital forms in British skulls, and complained of the publication by Dr. J. Barnard Davis of a paper on this subject in the *Natural History Review*, in which he claimed the origination of the idea, without noticing my previously-published views, which references in the '*Crania Britannica*' showed to have been previously known to him. I wrote at the same time a lengthened paper for the *Canadian Journal* entitled 'Ethnical Forms and Undesigned Artificial Distortions of the Human Cranium,' with a view to the more complete elucidation of my views: and as this was written under the belief that those already published by me had been deliberately ignored, it is characterized by a controversial tone which I should not otherwise have assumed. Immediately on reading Dr. Davis's courteous reply in the *Athenæum* of Sept. 27th, in which he states that the omission of any reference to my prior publication 'was an oversight resulting from lapse of memory alone,' I wrote to him expressing my regret at the occurrence of such a correspondence, owing to our severance by the Atlantic preventing my receiving his explanation till months after the appearance of his paper. As I now find that Dr. Davis is much more sensitive on the personal aspects of the correspondence than on the question of priority of origination of the opinions there discussed, I shall feel gratified by your affording me an opportunity for expressing with equal publicity my undiminished esteem for him, and my regret that any controversial element should have mingled with our interchange of opinions. I willingly reciprocate the friendly feeling he expresses, and gladly retract whatever in the tone or terms of my former letter can be otherwise than agreeable to him. Such mutual good feeling need not interfere with the utmost freedom in the expression of diversity of opinions; and as to my communication to the *Canadian Journal* (Sept. 1862), I have pleasure in being able to place its columns at his disposal, and invite his reply to what I have published there, where it will be seen by all the readers of my paper.

"I am, &c.,

DANIEL WILSON.

"P.S. I forward this letter by the hands of Dr. J. Barnard Davis."

No. 4. *To the Editor of the Canadian Journal.*

Shelton, Staffordshire, Dec. 20, 1862.

SIR,—The following correspondence has a very intimate connection with the memoir entitled "Ethnical Forms and Undesigned Artificial Distortions of the Human Cranium," by Prof. Daniel Wilson, LL.D., which appeared in your excellent *Journal*, No. XLI., September, 1862, p. 399, and I shall esteem it an act of politeness if you will allow it to appear in the pages of *The Canadian Journal.*

Dr. D. Wilson has very handsomely invited me to reply to his long article, in which he thought proper to comment so freely upon my views, &c., *before seeing what I had to say to his communication in The Athenæum of September* 20; but I feel that in any attempt to reply, however intended, there could scarcely be avoided some appearance of that personal reflection which I sincerely deprecate and lament, or what might be assumed to be such an appearance. I shall therefore confine myself to two or three remarks, principally referring to facts, which, with the concurrence of Dr. Wilson, through whom this communication is transmitted, may be more correctly stated in your pages.

1. Dr. Wilson very properly, at pages 412 and 413, of his memoir, corrects the error into which I had fallen in referring the flattening of the occipital region, in the Juniper Green Cranium, to *posthumous* influences. Being interred in a *cist*, and not exposed to posthumous pressure, such could not be the cause. But he overlooks my own correction of this error, made long before, in different pages of the "Crania Britannica"—Description of Newbigging Skull, pl. 21,

p. (4); Description of the Caedegai Skull, pl. 23, p. (3); Description of Green Lowe Skull, pl. 41, p. (2), &c.

2. I find the readers of Dr. Wilson's memoir regard it as a laudation of my coadjutor, Dr. Thurnam, no doubt for very just and valid reasons, whilst it is, at the same time, a condemnation of myself. I conclude such was not the object of the writer, but it has insensibly resulted from his different treatment of two persons. In some cases, he appears even to have complimented the one at the expense of the other. There is, however, one passage at page 430, in which, by some singular confusion or misleading feeling, he has attributed to that other a sentence in the "Crania Britannica" with which Dr. Wilson is deeply offended, and yet the sentence itself is quite clear in referring its authorship to Dr. Thurnam. Whilst I am disposed to bear my own heavy sins, for which I am happy to say the just and natural apology I have made has produced me full forgiveness, it seems hard to make me the scape goat for the offences of my neighbours, even although they are much purer and better than myself. The sentence is this, referring to the skulls described in Dr. D. Wilson's learned and pleasing volume, "The Archæology and Prehistoric Annals of Scotland," I said: "Further inquiry has produced a serious question of the authenticity of some of the series. The skulls of the supposed Druids of Iona and the Hebrides, *Dr. Thurnam has ascertained* are doubtless those of Christian monks of the eighth or ninth century."—Cran. Brit., p. 21, note. I know not that I ever saw the skulls in question, and I am utterly incapable of giving any opinion upon them. Therefore, however apologetic towards my reputed offence the succeeding comment of Dr. Wilson may be, I must deserve to be wholly exonerated from the supposed delinquency in this case. Dr. Wilson writes: "In the brevity of his note Dr. Davis has probably compressed his remarks into a form implying somewhat more than they were intended to convey; but from the remaining portion of the above comment, no reader unfamiliar with the original text could fail to understand that I had produced certain spurious skulls as Druids of Iona."—(Ethnical Forms, p. 431). Of whatever else I may have been guilty, *I* must assuredly be acquitted of making such an unjust insinuation. It was not mine, that is plain to any reader, and I firmly believe its real author had not the most remote idea that any one could deduce from it an insinuation so unfounded. The heat of argument has sadly misled Dr. Wilson in this portion of his memoir.

3. At page 433, Dr. Wilson quotes from the "Crania Britannica,"—Description of Green Gate Hill Skull, pl. 3 and 4, p. (3): "These differences will go far to render questionable the opinion which has been assumed, that by ascending to the earliest pre-historic times we shall find the crania endowed with uniformity, or, as it were, stereotyped." To which he adds: "An idea not to be met with, so far as I am aware, elsewhere." I can assure Dr. Wilson that the idea is not mine, but that of an able advocate of pre-historic races. In Dr. W. R. Wilde's "Ethnology of the Ancient Irish," he says: "Although we find every variety of head among the modern mixed races of civilized countries, when we come to examine primitive or savage tribes we find the character of their crania and general physical condition more and more *stereotyped* as we recede from civilization."—P. 11.

4. The tone and temper of Dr. Wilson's memoir, where it comments so severely upon myself and the views I have been led to take upon the subject of a precedent and pre-historic race before the Ancient Britons, and who were distinguished by dolicho-cephalism, or kumbe-cephalism, seems to me to be singularly misplaced, if I may be excused the expression, on this ground, viz., that in the consideration of this pre-celtic hypothesis in the "Crania Britannica," I have always treated the opinions of its supporters with the utmost respect and deference, and even opposed them with reluctance. In the Description of the Long Lowe Skull, pl. 33, where the subject is discussed at most length, this passage occurs: "The pre-celtic hypothesis is received by investigators deserving so much respect and confidence, that we feel both bound and anxious to do ample justice to every fact of the case, and to exercise the utmost candour in the estimation of the hypothesis itself."—P. (4). This passage was written in all sincerity, and I am not aware of any page in the work in which I have deviated from the spirit which it expresses.

5. I confess to one delinquency with which I am charged, to this extent, that I may have manifested some change in my views upon some points in the course of the seven years during which the "Crania Britannica" has been in progress, and thus given opportunity to Dr. Wilson to point out some trifling inconsistencies. My opinions were not "crystallized" when my labours commenced, and, I am ready to acknowledge, even now, that they are not in that completed and fixed state, that the rays of light which Dr. Wilson and other inquirers may yet cause to shine into my mind must necessarily be wholly inoperative upon them.

Finally, I cannot help regretting that any act of carelessness on my part should have occasioned any uneasiness to my friend Dr. D. Wilson, to whom I owe so many favours and acts of kindness. I can assure him that it is a source of congratulation to European craniologists that the learned and acute author of "The Archæology and Prehistoric Annals of Scotland," and of the recent and elaborate volumes on the curious subject of "Prehistoric Man," should have directed his attention to the subject of cranial forms among the American races, and the strange difformities to which they have been exposed. In this branch of inquiry he has already shown, what I have long anticipated, that great differences of skull-forms have existed among these numerous and diversified nations,—doubtless coincident with their other diversities.

I am, &c., J. Barnard Davis.

No. 5. *To the Editor of the Canadian Journal.*

University College, Toronto, Jan. 19, 1863.

Sir,—Having invited Dr. Davis to avail himself of the pages of this journal for any counter-statement he desired to make to my paper on "Artificial Distortions of the Human Cranium," I enclose herewith his reply. In this, as it appears to me, he fails to discriminate between expressions of dissent from his opinions, and an attack on himself; the latter of which I altogether disclaim. After having been familiar for years with the utmost freedom of critical assault on my own published opinions, I find it difficult to appreciate his extreme sensitiveness on this point; or to understand why the most friendly relations either with him or Dr. Thurnam should prevent my controverting their opinions as freely as they know I have allowed them to challenge mine. They are both well aware that their adverse comments on my views as set forth in the "Prehistoric Annals of Scotland"—to which I recently replied in this journal,—made no change either in my correspondence with them, or in my exertions on behalf of their joint work.

Dr. Davis forgets the object of my letter to the *Athenæum*, and the article of same date in this Journal, when he speaks of my overlooking his corrections of his earlier error in relation to *posthumous* influences. I referred to a specific date in 1857, when I published certain opinions, and showed by reference to the *Crania Britannica*, that previous to their publication the views he held were incorrect. It was no part of my object to review his subsequent opinions. He says himself, in letter 2, he cannot tell whether he availed himself of my hint, or not, in these subsequent views. On this point I express no opinion; but I have failed to perceive any essential distinction between what he calls "a different point, viz., parieto-occipital flatness," and what I had long before referred to as "the vertical or flattened occiput."

The reader who turns to the *Crania Britannica*, p. 21, or to the passage quoted from it in this Journal (ante, vol. vii., p. 430), will probably be inclined to think with me, that a passage written by Dr. Davis, in which he states in his own words certain opinions, which he ascribes to Dr. Thurnam, is his, and not Dr. Thurnam's. My answer, however, to the opinions therein expressed is the same, whoever may be responsible for them.

As Dr. Davis writes now at my invitation, I shall leave his remarks to the impartial consideration of your readers, without comment; and only add in explanation of the course I pursued, that my letter to the *Athenæum*, was necessarily limited to the claim of priority of publication of the views in question. My article in the *Canadian Journal* for September, written simultaneously with it, set forth in detail what these views are. When Dr. Davis complains that the latter was written *before seeing what he had to say to my communication*, he forgets that his article,—in which he communicated to the scientific world, in *July* 1862, as an original discovery, what he now admits to have been suggested by me, in this *Journal*, so early as Nov., 1857,—not only was already in circulation among the readers of the *Natural History Review*, to whom I have no such access as I have accorded to him in these pages; but it remains there uncorrected to the present day.

I am, &c.,

Daniel Wilson.

NATURAL HISTORY.

To the Editor of the Canadian Journal.

Peterboro, C. W., January 14th, 1863.

Dear Sir,—Some four or five years ago I had the pleasure to offer to the Institute a tolerably good specimen of that most interesting *Rodent*, the *Castor Fiber:* and with the skin I forwarded a certificate to the effect that the animal was shot by a lad with whom I am acquainted, on the margin of a stream running between the village of Lakefield, in the Township of Douro, and the Town of Peterboro, at a spot situated but six miles from the latter place.

It may not be uninteresting to those Members of the Institute who make the *Fauna* of Canada their study, to learn that another individual of the same species was trapped, a few weeks since, in the Township of Monaghan, in a creek *within three miles of this town.* The Beaver weighed, when killed, forty-six pounds, and measured four feet eight inches in length.

It is well known to Naturalists that the nail of the second toe of each hind foot of the Beaver is invariably split; it is, in fact, a *double* nail. *Cui Bono?* I should esteem it a favour if any of your correspondents will adduce a reason for this peculiarity; for that some sufficient reason *can* be assigned I entertain not the shadow of a doubt.

Beavers are more abundant than usual in our County this season, and I have recently seen some very fine cuttings in the neighbourhood of Stony Lake; one, of poplar, eighteen inches in diameter. It is said that a single Beaver will "fall" a tree of that size in the space of half-an-hour.

I am, dear Sir, yours faithfully,
VINCENT CLEMENTI.

GEOLOGY AND MINERALOGY.

ORIGIN OF LAKE BASINS.

In an interesting paper on the lakes of Switzerland, etc., published in a recent number of the *Journal of the Geological Society*, Professor Ramsay maintains the glacial origin of the basins of these lakes, and he attributes a similar origin or mode of formation to the great lake basins of this continent. In this view, Prof. Ramsay states that he is supported by the opinion of Sir William Logan, who points out that our northern lakes are in true rock-basins, in areas occupied by comparatively soft deposits surrounded by harder rocks; the arrangement of the strata proving, moreover, that these lakes do not lie in areas of special subsidence. After a detailed review of the leading characteristics of the Alpine lakes, Prof. Ramsay condenses the evidence in support of his conclusions into the following summary. He remarks:

1st. That each of the great lakes lies in an area once covered by a vast glacier. There is, therefore, a connexion between them which can scarcely be accidental.

2nd. I think the theory of an area of *special subsidence* for each lake untenable, seeing no more proof for it in the case of the larger lakes than for the hundreds of tarns in perfect rock-basins common to all glacier-countries, present or past, and the connexion of which with diminished or vanished glaciers I proved originally in "The Old Glaciers of North Wales." In the Alps there is a gradation in size between the small mountain-tarns and the larger lakes.

3rd. None of them lie in lines of *gaping fracture.* If old fractures ran in the lines of the lakes or of other valleys, and gave a tendency to lines of drainage, they are nevertheless, in the deep-seated strata, exposed to us as close fractures now, and the valleys are valleys of erosion and true denudation.

4th. They are none of them in simple synclinal basins, formed by the mere disturbance of the strata after the close of the Miocene epoch ; nor,

5th. Do they lie in hollows of common watery erosion; for running water and the still water of deep lakes can neither of them excavate profound basin-shaped-hollows. So deeply did Playfair, the exponent of the Huttonian theory, feel this truth, that he was fain to liken the Lake of Geneva to the petty pools on the New Red Marl of Cheshire, and to suppose that the hollow of the lake had been formed by the dissolution and escape of salts contained in the strata below.

6th. But one other agency remains—that of ice, which, from the vast size of the glaciers, we are certain must have exercised a powerful erosive agency. It required a solid body, grinding steadily and powerfully in direct and heavy contact with and across the rocks, to scoop out deep hollows, the situations of which might either be determined by unequal hardness of the rocks, by extra weight of ice in special places, or by accidental circumstances, the clue to which is lost, from our inability perfectly to reconstruct the original forms of the glaciers.

7th. It thus follows that, valleys having existed giving a direction to the flow of the glaciers ere they protruded on the low country between the Alps and the Jura, these valleys and parts of the plain, by the weight and grinding power of ice in motion, were modified in form, part of that modification consisting in the excavation of the lake-basins under review.

In connexion with this point, it is worthy of remark that glaciers, many of them very large in the modern sense of the term, on the south side of the Vallais (excepting those of Mont Blanc), and the large glaciers on the south side of the Oberland, all drain into the Lake of Geneva; those on the north of the last-named snow-field, also large glaciers, are drained through the Lakes of Brienz and Thun. These, among the largest existing glaciers of the Alps, are only the shrunken tributaries of the greater glaciers that in old times filled and scooped out the basins of the lakes. The rest of the lakes, as already stated, are in equally close connexion with the old snow-drainage of glacier-regions on the grandest scale,—all of them, excepting those of Neuchâtel, Bienne, and Morat, lying in the direct course of glaciers filling valleys that extend right into the heart of the mountains.

8th. Most of the lakes are broad or deep according to the size of the glaciers that flowed through the valleys in which they lie, this general result being modified according to the nature of the rock and the form of the ground over which the glacier passed. Thus, the long and broad Lake of Geneva, scooped in the Miocene lowlands, is 984 feet deep, and over its area once spread the broad glacier of the Rhone. Its great breadth and its depth evince the size of the glacier that overflowed its hollow. The Lake of Constance, lying in the same strata, and equally large, is 935 feet deep, and was overspread by the equally magnificent glacier of the Upper Rhine. The Lakes of Maggiore and Como, deepest of all, lie in the narrow valleys of the harder Secondary rocks of the older Alps; and the bottom of the first is 1992 feet, and the latter 1043 feet, below the sea level. Both of these lie within the bounds of that prodigious system of glaciers that descended from the east side of the Pennine Alps and the great ranges north and south of the Val Tellina, and shed their moraines in the plains of Piedmont and Lombardy. The depths of the lakes correspond to the vast size and vertical pressure of the glaciers. The circumstance that these lakes are deeper than the level of the sea does not affect the question, for we know nothing about the absolute height of the land during the Glacial period.

The Lakes of Thun and Brienz form part of one great hollow, more than 2000 feet deep in its eastern part, or nearly 300 feet below the level of the sea. They lie in the course of the ancient glacier of the Aar, the top of which, as *roches moutonnées* and striations show, rose to the very crests of the mountains between Meyringen and the Grimsel.

The Lake of the Four Cantons is imperfectly estimated at only 884 feet in depth; but here we must also take into account the great height and steep inclines of the mountains at its sides. The Lake of Zug, 1311 feet deep, lies in the course of the same great glacier, the gathering-grounds of which were the slopes that bound the tributaries of the Upper Reuss and the immense amphitheatre of the Urseren Thal, bounded by the Kroutlet, the Sustenhorn, the Galenstock, the St. Gothard, and the southern flanks of the Scheerhorn.

The lesser depths (660 feet) of the Lake of Zurich were hollowed by the smaller but still large glacier that descended the valley of the Linth.

Passing then to an examination of the lakes of the Northern Hemisphere generally, Professor Ramsay concludes as follows:

Furthermore, considering the vast areas over which the phenomena described are common in North America and Europe, I believe that this theory of the origin of lake-rock-basins is an important point, in addition to previous knowledge, towards the solution of the glacial theory; for I do not see that these hollows can in any way be accounted for by the hypothesis that they were scooped by floating ice.* An iceberg that could float over the margin of a deep hollow would not touch the deeper recesses of the bottom. I am therefore constrained to return, at least in part, to the theory many years ago strongly advocated by Agassiz, that, in the period of extremest cold of the Glacial epoch, great part of North America, the north of the Continent of Europe, great part of Britain, Ireland, and the Western Isles, were covered by sheets of true glacier-ice in motion, which moulded the whole surface of the country, and in favorable places scooped out depressions that subsequently became lakes.

This was effected by the great original glaciers (probably connected with the origin of the *unstratified* boulder-clay) referred to in my memoir on the glaciers of North Wales, but the magnitude of which I did not then sufficiently estimate.

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* I do not in any way wish to deny that much of the glaciation of the lower countries that came within the limits of the Drift was effected by floating ice on a large scale, which must have both polished and striated the rocks along which it ground. I have, with other authors, described this in various memoirs. But the two sets of phenomena are distinct.

The cold, however, continued during the depression of North Wales and other districts beneath the sea, when they received the *stratified* erratic drift; and glaciers not only did not cease at this time of depression, but were again enlarged during the emergence of North Wales and other countries, so as to plough the drift out of many valleys. These enlarged glaciers, however, bore no comparison in size to the great original sheets of ice that converted the north of Europe and America into a country like North Greenland. The newer development of glaciers was strictly local. Amelioration of climate had already far advanced, and probably the gigantic glaciers of Old Switzerland were shrinking into the mountain-valleys.

Finally, if this be true, I find it difficult to believe that the change of climate that put an end to this could be brought about by mere changes of physical geography. The change is too large and too universal, having extended alike over the lowlands of the Northern and the Southern Hemispheres. The shrunken or vanished ice of mountain-ranges is indeed equally characteristic of the Himalaya, the Lebanon, the Alps, the Scandinavian chain, the great chains of North and South America, and of other minor ranges and clusters of mountains like those of Britain and Ireland, the Black Forest, and the Vosges.

MINERALOGICAL NOTICES.

Meteoric Stone of Chassigny.—This celebrated meteorite, first examined by Vanquelin in 1816, a few months after its fall, has been recently analysed by Damour, and shewn to exhibit the formula of a ferruginous chrysolite, viz.:—$2RO, SiO^2$—in which $RO = \frac{1}{3} FeO + \frac{2}{3} MgO$ (*Comptes Rendus*, LV., No. 15). The stone, with a sp. gr. 3·57, has a pale greenish-yellow colour, and is quite free from metallic iron. Partsch, in his well-known catalogue of the Meteorites in the Royal Collection at Vienna, describes it as one of remarkable peculiarity. Although small grains of chrysolite (or olivine) have been observed in various meteorites, this is the only known example of a meteoric stone composed essentially of that mineral.

Forcherite.—Under this name, Prof. Auhkom, in 1860, described a hydrated siliceous substance, of a yellow colour, from Reittelfield in Upper Styria. A more recent examination by R. L. Maly (*Journ. fur prak. Chemie*, Sept. 1862), has shewn the substance in question to be an opal, accidentally coloured by variable proportions of sulphide of arsenic (orpiment?) The term *Forcherite* as applied to this variety of the opal, will not obtain admission, it is to be hoped, into the already overcrowded lists of mineralogical synonymes.

Composition of Staurolite and Tourmaline.—During the course of last year, Rammelsburg made known the presence of protoxide of iron (a fact already pointed out, however, by the writer of these notes, in 1848). Mitscherlitch has subsequently ascertained that all the iron is in that condition (*Journ. f. prak. Chem.*, *Bd.* 86). He has also re-examined various tourmalines and found that no sesquioxide of iron is properly present in these, but only FeO. A satisfactory formula for either staurolite or tourmaline, nevertheless, is still to be deduced.

E. J. C.

MONTHLY METEOROLOGICAL REGISTER, AT THE PROVINCIAL MAGNETICAL OBSERVATORY, TORONTO, CANADA WEST,—OCTOBER, 1862.

Latitude—43 deg. 39.4 min. North. Longitude—5 h. 17 min. 33 sec. West. Elevation above Lake Ontario, 108 feet.

Day.	Barom. at temp. of 32°.				Temp. of the Air.				Excess of mean above Normal.	Tens. of Vapour.				Humidity of Air.				Direction of Wind.			Resultant Direction.	Velocity of Wind.					Rain in Inches	Snow in Inches.
	6 A.M.	2 P.M.	10 P.M.	MEAN.	6 A.M	2 P.M.	10 PM	ME'N		6 A.M	2 P.M.	10 P.M.	M'N	6 A.M	2 P.M.	10 P.M.	M'N	6 A.M.	2 P.M.	10 P.M		6 A.M	2 P.M	10 PM	Re-sul't.	ME'N		
1	29.758	29.748	29.737	29.7472	44.6°	52.2°	54.7°	50.27°	— 0.15°	.264	.358	.403	.338	.90	.92	.94	.92	N E	E	E	N 60° E	10.5	6.4	6.2	5.59	5.83	0.085	...
2	.682	.614	.701	.6667	53.6	61.8	59.4	58.47	+ 8.53	.406	.504	.498	.473	.99	.91	.98	.96	N b E	S b W	Calm.	S 53 E	0.5	0.4	0.0	0.28	0.65	0.087	...
3	.735	.652	.572	.6453	58.7	61.9	60.9	60.80	+11.27	.480	.542	.528	.521	.97	.98	.99	.97	S E b E	E b N	E b S	N 78 E	1.0	6.4	2.0	3.48	3.53	0.565	...
4	.414	.337	.680	.4992	60.5	72.0	52.9	61.03	+12.00	.521	.500	.235	.400	.99	.63	.58	.72	E b S	W	N W b W	N 86 W	1.5	27.0	27.0	15.05	17.21	0.072	...
5	.918	.950	—	—	42.5	58.3	—	—	—	.218	.333	—	—	.80	.68	—	—	N W b W	N N W	Calm.	N 28 W	1.8	7.0	0.0	3.70	3.88	...	...
6	.797	.572	.363	.5555	43.5	58.3	60.5	54.63	+ 6.42	.231	.390	.442	.370	.82	.80	.84	.85	Calm.	S	S W b W	S 23 W	0.0	3.2	4.2	4.11	4.76	0.185	...
7	.414	.390	.368	.3917	62.3	73.5	67.0	67.55	+19.70	.536	.671	.566	.593	.95	.81	.85	.88	S W b S	S W b S	S W	S 41 W	10.5	11.2	5.5	6.31	6.32	Inp.	...
8	.416	.373	.381	.3937	65.9	76.0	68.4	69.38	+21.93	.488	.605	.618	.554	.76	.67	.89	.77	S W b S	S W	S W	S 52 W	6.2	15.2	13.2	8.27	10.89	0.175	...
9	.605	.735	.816	.7363	55.8	57.2	52.9	54.95	+ 7.88	.377	.337	.338	.339	.85	.71	.84	.78	N W b N	N N W	N b E	N 7 W	0.5	2.8	4.0	3.08	3.29	0.030	...
10	.779	.569	.568	.6338	50.4	51.8	45.0	48.42	+ 1.75	.288	.290	.288	.292	.78	.75	.96	.86	N N E	N N E	N	N 1 E	5.5	10.8	9.0	8.95	9.53	0.270	...
11	.699	.740	.776	.7502	44.3	53.6	42.5	46.15	— 0.10	.239	.297	.190	.242	.82	.72	.70	.76	N N W	N b W	N N W	N 20 W	6.8	2.5	4.0	5.49	5.58	0.050	...
12	.810	.741	—	—	36.3	52.6	—	—	—	.176	.259	—	—	.82	.65	—	—	N	E b S	E b S	N 73 E	4.5	4.5	4.0	3.00	3.81	...	...
13	.619	.561	.533	.5758	42.5	57.6	50.0	50.10	+ 4.53	.244	.353	.324	.310	.89	.74	.89	.85	N b E	S E b S	Calm.	N 79 E	5.0	2.2	0.0	0.43	1.30	...	...
14	.601	.633	.796	.6910	41.4	55.8	42.1	46.02	+ 0.75	.250	.322	.223	.259	.95	.72	.83	.83	N W	N W b N	N N W	N 25 W	1.0	13.8	4.5	8.01	8.34	...	...
15	.902	.861	.724	.8213	36.0	41.0	39.9	38.92	— 5.93	172	.193	.211	.191	.81	.75	.86	.81	N E	N E	N b E	N 68 E	4.0	2.5	2.4	2.66	3.43	...	...
16	.577	.448	.428	.4817	45.0	48.2	47.9	47.03	+ 2.50	.278	.307	.311	.290	.94	.91	.93	.90	S E b E	S W	W S W	S 44 W	5.0	3.0	1.0	2.50	3.92	0.055	...
17	.537	.667	.848	.7038	41.4	53.3	41.7	44.98	+ 0.75	.232	.240	.210	.219	.89	.58	.79	.74	W b N	W N W	N W b N	N 65 W	6.0	11.8	2.0	4.70	4.78	...	...
18	.922	.799	.651	.7882	34.5	57.2	49.7	47.70	+ 3.67	.181	.303	.298	.265	.90	.64	.84	.79	Calm.	S b W	Calm.	S 25 W	0.0	9.6	0.0	5.08	5.35	...	...
19	.481	.490	—	—	49.3	52.2	—	—	—	.323	.203	—	—	.91	.50	—	—	W S W	W N W	N W	N 61 W	8.8	17.0	15.5	13.03	13.76	0.020	...
20	.758	.675	.454	.6150	30.2	45.0	49.0	42.78	— 0.78	.149	.221	.256	.213	.89	.74	.74	.76	N W b N	S S W	S	S 21 W	1.0	7.5	10.5	8.79	9.09	...	...
21	.194	.101	.047	.1168	51.8	50.4	46.4	48.77	+ 5.52	.290	.340	.298	.302	.75	.93	.94	.87	S S W	S W	S b W	S 56 W	13.0	5.5	1.0	6.61	7.40	0.635	...
22	.125	.295	.551	.3430	42.1	46.8	40.7	42.77	— 0.20	.204	.180	.231	.206	.76	.55	.91	.76	W b S	W N W	W N W	N 67 W	13.8	25.8	10.5	16.22	16.57	Inp.	...
23	.773	.910	.866	.8585	35.2	43.2	36.3	38.23	— 4.52	.190	.198	.193	.192	.93	.70	.90	.83	N b W	W N W	Calm.	S 83 W	0.5	14.5	0.0	2.32	4.80	0.040	...
24	.736	.555	.703	.6628	45.0	52.6	46.4	47.45	+ 4.95	.230	.310	.249	.253	.77	.78	.79	.77	S	S W b S	N W b W	S 79 W	10.0	13.8	16.8	8.25	11.67	0.100	...
25	.884	.973	30.039	.9735	37.0	38.5	32.0	35.37	— 6.92	.183	.173	.166	.175	.84	.74	.91	.85	W N W	N	N	N 11 W	6.5	7.4	6.2	5.61	6.50	..	Inp.
26	.918	.775	—	—	30.9	31.3	—	—	—	.164	.160	—	—	.95	.90	—	—	N E b N	N b E	N b E	N 14 E	8.8	6.6	4.0	5.11	5.57	...	0.5
27	.528	.486	29.586	.5402	27.0	42.1	32.7	34.77	— 7.02	.136	.179	.172	.167	.93	.66	.92	.83	N W b N	W N W	Calm.	N 47 W	1.0	12.0	0.0	3.69	3.82	...	...
28	.655	.640	.654	.6478	32.7	45.4	41.4	40.43	— 1.05	.172	.234	.232	.216	.92	.77	.89	.86	Calm.	S E b E	W b S	S 14 E	0.0	0.5	1.0	3.01	3.29	0.315	...
29	.571	.654	.818	.7022	43.5	47.0	36.7	42.13	+ 0.87	.268	.223	.183	.223	.95	.68	.86	.83	S W b S	W	W b N	N 88 W	1.8	12.2	4.0	7.20	7.33	Inp.	...
30	.813	.557	.577	.6472	35.6	52.2	45.4	44.75	+ 3.80	.193	.275	.234	.235	.93	.70	.77	.79	N W	S	S W	S 24 W	0.5	4.4	1.0	2.09	3.70	Inp.	...
31	.607	.451	.518	.5188	41.7	57.6	51.8	51.17	+10.42	.228	.332	.249	.269	.86	.69	.64	.71	Calm.	S W b S	S W b W	S 42 W	0.0	13.5	5.8	6.19	6.42	...	...
M	29.6334	29.5924	29.6206	29.6188	44.53	53.79	47.94	48.70	+ 3.66	.275	.329	.302	.300	.88	.75	.85	.82	......	......	......	......	4.39	9.06	5.33	......	6.53	2.684	0.5

REMARKS ON TORONTO METEOROLOGICAL REGISTER FOR OCTOBER, 1862.

Highest Barometer........................ 30.039 at 10 p. m. on 25th } Monthly range =
Lowest Barometer .... 29.047 at 10 p. m. on 21st } 0.992 inches.
Self-regist'ing Thermom. { Maximum Temperature .... 76°6 on p.m. of 8th } Monthly range=
Minimum Temperature .... 26°2 on a.m. of 27th } 50°4
Mean maximum Temperature .... 51°80 } Mean daily range=
Mean minimum Temperature .... 41°43 } 13°36
Greatest daily range .... 28°2 from a. m. to p.m. of 18th.
Least daily range.................. 2°8 from a. m. to p. m. of 26th.
Warmest day......... 8th... Mean temperature......... 69°38 } Difference = 34°61.
Coldest day .... 27th... Mean temperature......... 34°77 }
Maximum { Solar..................................98°0 on p.m. of 7th } Monthly range =
Radiation. { Terrestrial..................................19°6 on a.m. of 27th } 78°4
Aurora observed on 6 nights, viz.,—4th, 11th, 12th, 13th, 22nd, and 29th.
Possible to see Aurora on 12 nights; impossible on 19 nights.
Snowing on 2 days, depth 0.5 inches; duration of fall, 4.0 hours.
Raining on 19 days,—depth 2.684 inches; duration of fall 71.7 hours.
Mean of cloudiness = 0.72. Above average 0.10.
Most cloudy hour observed, 4 p. m., mean = 0.77; least cloudy hour observed, mid.; mean, = 0.66.

Sums of the components of the Atmospheric Current, expressed in miles.

North.	South.	East.	West.
1786.81	1340.52	519.17	2622.61

Resultant direction N. 78° W.; Resultant velocity 2.89 miles per hour.
Mean velocity ....6.53 miles per hour.
Maximum velocity .... 38.2 miles, from 11 a.m. to noon on 22nd.
Most windy day ......4th ....Mean velocity, 17.21 miles per hour. } Difference=
Least windy day......2nd ....Mean velocity, 0.65 ditto. } 16.56 miles.
Most windy hour ...1 p.m. to 2 p.m. ....Mean velocity, 9.55 ditto. } Difference=
Least windy hour...5 a.m. to 6 a.m. ....Mean velocity 3.95 ditto. } 5.60 miles.

1st. Foggy 10 p.m. and midnight.—2nd. Dense fog 6 and 8 a.m. and 10 p.m. and midnight.—3rd. Dense wetting fog all day.—4th. Ground fog 6 a.m.; distant thunder 9 a.m.; wind high and squally.—7th. Sheet lightning in N. E. at 6 p.m.; sultry day.—8th. Sheet lightning in W. at 7.30 p.m.; very sultry day.—9th. Imperfect rainbow at 6.20 a.m.—11th. Rainbow 3.30 to 4.10 p.m.—12th. Thin ice at 6 a.m.—14th. Dense fog 6 to 7 a.m.—17th. Thin ice at 6 a.m.—18th. Thin ice at 6 a.m.—19th. Shower of hail and rain 6.30 to 9 a.m.—21st. Severe thunderstorm 8 to 9 p.m.; loud thunder, vivid lightning, heavy rain, and very large hailstones.—25th. Particles of snow 9.30 a.m. to 3.30 p.m., *(first of the season.)*—26th. Light snow 6 to 11.30 a.m.—28th. Lunar halo during the evening.

Heavy Dew recorded on 2 mornings during this month.—Indian Summer, 29th Oct. to 2nd Nov. Inclusive.—Rapid descent of temperature: from 4th p.m. = 73°8, to 5th a.m. = 40°4; range in 16 hours = 33°4.—The month of October, 1862, was comparatively mild, wet, windy, and cloudy.

COMPARATIVE TABLE FOR OCTOBER.

YEAR.	TEMPERATURE.					RAIN.		SNOW.		WIND.		
	Mean.	Excess above aver'ge (45.5)	Max. ob-served.	Min. ob-served.	Range.	No. of days.	Inches	No. of days.	Inches	Resultant. Direction.	Resultant. V'y.	Mean Force or Velocity.
1840	° 44.4	° — 1.1	° 68.5	° 23.9	° 44.6	13	1.860	3	...	...	...	....
1841	41.6	— 3.9	58.3	20.3	38.0	6	1.360	2	...	...	...	0.41 ℔s.
1842	45.1	— 0.4	68.5	30.0	38.5	8	5.175	0	...	...	...	0.35
1843	41.8	— 3.7	65.7	24.5	41.2	12	3.790	4	2.5	...	...	0.54
1844	43.3	— 2.2	69.6	17.8	51.8	7	Imp.	4	12.0	...	...	0.43
1845	46.4	+ 0.9	62.7	20.0	42.7	11	1.760	1	Inp.	...	...	0.26
1846	44.6	— 0.9	69.7	20.7	49.0	14	4.180	2	Inp.	...	...	0.44
1847	44.0	— 1.5	65.0	20.3	44.7	13	4.390	2	Inp.	...	...	0.19
1848	46.3	+ 0.8	62.2	26.4	35.8	11	1.550	0	0.0	N 54° W	1.24	4.60mls.
1849	45.3	— 0.2	59.2	25.5	33.7	13	5.965	1	Inp.	N 12° W	1.27	4.76
1850	45.4	— 0.1	66.6	24.8	41.8	10	2.085	0	0.0	N 66° W	1.10	5.30
1851	47.4	+ 1.9	66.1	25.0	41.1	10	1.680	2	0.3	S 72° W	1.06	4.39
1852	48.0	+ 2.5	70.7	29.8	40.9	12	5.280	0	0.0	N 5° E	1.19	4.47
1853	44.4	— 1.1	64.7	25.5	39.2	10	0.875	2	Inp.	S 88° W	1.74	4.77
1854	49.5	+ 4.0	74.2	29.8	44.4	15	1.495	3	Inp.	N 45° W	1.52	4.57
1855	45.4	— 0.1	64.3	28.0	36.3	14	2.485	5	0.8	N 82° W	4.91	9.88
1856	45.3	— 0.2	70.1	23.3	46.8	10	0.875	2	0.1	N 76° W	2.15	6.07
1857	45.4	— 0.1	63.5	27.7	35.8	10	1.040	2	0.2	N 19° W	2.93	6.24
1858	48.8	+ 3.3	76.3	34.2	42.1	17	1.797	1	Inp.	N 34° W	0.36	5.96
1859	43.0	— 2.5	68.4	22.3	46.1	11	0.940	4	Inp.	N 68° W	5.04	8.12
1860	47.3	+ 1.8	63.7	28.4	35.3	15	1.618	1	Inp.	N 9° W	2.00	6.93
1861	48.7	+ 3.2	64.5	30.2	34.3	15	1.993	1	Inp.	N 61° W	1.06	5.96
1862	48.7	+ 3.2	76.0	27.0	49.0	19	2.684	2	0.5	N 78° W	2.89	6.53
Results to 1861.	45.52	...	36.48	25.38	41.10	11.7	2.485	19	0.84	N 56° W	1.67	5.86
Exc. for 1862.	+ 3.18	...	+ 9.52	+1.62	+ 7.90	+ 7.3	+ 0.199	+ 0.1	— 0.34	....	......	+ 0.67

MONTHLY METEOROLOGICAL REGISTER, AT THE PROVINCIAL MAGNETICAL OBSERVATORY, TORONTO, CANADA WEST,—NOVEMBER, 1862.

Latitude—43 deg. 39.4 min. North. Longitude—5 h. 17 m. 33 s. West. Elevation above Lake Ontario, 108 feet.

Day.	Barom. at temp. of 32°.				Temp. of the Air.				Excess of mean above Normal.	Tens. of Vapour.				Humidity of Air.				Direction of Wind.			Resul't. Direction.	Velocity of Wind.					Rain in inches.	Snow in inches.
	6 A.M.	2 P.M.	10 P.M.	Mean.	6 A.M	2 P.M	10PM	ME'N		6 A.M.	2 P.M.	10 P.M.	M'N	6 A.M	2 P.M.	10 P.M.	M'N	6 A. M.	2 P. M.	10 P. M.		6 AM.	2 PM.	10 P.M.	Resul't.	ME'N		
					°	°	°	°	°												°							
1	29.601	29.514	29.496	29.5358	45.0	58.0	46.1	50.35	+ 9.88	.249	.305	.254	.265	.83	.62	.81	.72	Calm.	S S E	S b W	S 34 W	0.0	7.5	1.8	2.23	2.83	...	...
2	.466	.366	—	—	50.8	52.6	—	—	—	.303	.289	—	—	.81	.73	—	—	N W b N	N N W	N W b N	N 45 W	3.8	3.0	13.0	10.40	12.26	0.680	...
3	.366	.510	.792	.5782	39.6	43.5	32.7	37.65	— 2.35	.184	.186	.135	.160	.75	.66	.73	.70	W b N	N W b W	N	N 52 W	13.0	22.5	0.5	10.41	11.55	Inp.	...
4	.885	.832	.680	.7955	28.7	39.6	39.6	36.50	— 3.27	.123	.194	.219	.179	.77	.79	.90	.81	N E b N	E b S	Calm.	S 63 E	3.0	8.2	0.0	2.90	3.58	...	...
5	.546	.424	.636	.5497	34.5	49.3	34.5	38.37	— 1.12	.173	.242	.144	.185	.86	.68	.72	.78	E b N	N W b W	N N W	N 33 W	0.5	10.0	11.8	8.84	8.99	0.050	...
6	.713	.634	.695	.6867	26.2	33.1	28.4	28.62	—10.55	.110	.093	.112	.105	.77	.49	.72	.68	N b W	N W	N E	N 25 E	3.6	7.0	7.5	5.31	6.22	...	...
7	.778	.777	.789	.7753	23.0	30.6	27 7	27.33	—11.67	.106	.100	.113	.102	.86	.58	.74	.69	N E b N	N E b N	N b E	N 28 E	8.0	8.2	6.2	7.88	8.13	..	0.2
8	.712	.716	.758	.7357	23.7	28.0	28.4	26.65	—12.03	.118	.124	.142	.128	.93	.81	.90	.89	N N E	N b E	N N W	N 10 E	6.0	7.5	5.8	5.46	5.99	...	0.5
9	.782	.706	—	—	28.4	41.7	—	—	—	.135	.210	—	—	.86	.79	—	—	N W	N W b W	W	N 66 W	10.4	16.2	5.0	6.40	6.72	...	...
10	.789	.792	.792	.7985	34.9	45.4	34.5	37.95	— 0.13	.161	.162	.163	.166	.79	.52	.82	.73	W S W	W b N	N N E	N 53 W	3.2	8.0	2.0	2.89	4.35	...	...
11	.685	.456	.361	.4937	36.7	48.6	49.3	41.80	+ 7.02	.188	.221	.293	.236	.86	.64	.83	.79	E S E	S b W	S W b S	S 51 W	2.8	7.2	13.5	5.42	8.55	0.045	...
12	.629	.709	.648	.6780	40.7	41.0	37.4	39.33	+ 1.83	.213	.157	.196	.182	.84	.61	.87	.76	W N W	N W b N	Calm.	N 69 W	11.8	2.2	0.0	5.25	5.53	...	...
13	.755	.822	.834	.8030	37.4	42.8	40.3	39.38	+ 2.20	.179	.177	.193	.185	.80	.64	.77	.76	W b S	S W b W	S W	S 55 W	3.0	10.0	8.0	5.60	5.83	...	...
14	.741	.809	30.158	.9333	33.5	42 8	27.7	35.60	— 1.30	.182	.177	.121	.157	.78	.64	.80	.75	S W	W N W	N	N 41 W	2.0	14.4	10.4	9.53	11.97	Inp.	Inp.
15	30.391	30.426	30.442	30.4273	17.2	27.0	24.8	22.80	—13.70	.087	.107	.105	.099	.91	.73	.79	.81	N	E S E	N E	N 50 E	5.2	7.5	5.8	7.31	7.75	...	...
16	30.345	30.191	—	—	24.4	35.3	—	—	—	.117	.164	—	—	.89	.80	—	—	N E b E	E	S S E	S 65 E	10.5	7.4	6.5	5.45	6.27	0.225	...
17	29.896	29.880	30.062	29.9553	39.9	49.3	41.4	43.13	+ 7 33	.233	.303	.187	.236	.95	.86	.72	.84	S E b S	N W b N	N	N 17 W	0.2	10 0	4.2	3 71	4.49	Inp.	...
18	30.061	.930	29.741	.8950	37.4	41.7	39.9	39.57	+ 4.08	.179	.218	.224	.210	.80	.82	.91	.86	N E	E	N E b E	N 78 E	0.8	4.8	2.2	2.85	3.37	0.260	Inp.
19	29.546	.421	.367	.4393	41 7	43.9	42.1	42.58	+ 7.50	.255	.263	.267	.262	.96	.92	1.00	.96	N N E	N	N	N 10 E	5.6	5.6	9.0	5.75	5.82	0.660	...
20	.215	.317	.468	.3497	38.5	36.0	32.9	34.87	+ 0.10	.208	.172	.155	.173	.89	.81	.83	.85	N b E	N	N	N 7 W	7 8	12.2	7.2	7.93	8.07	0.285	Inp.
21	.531	.495	.494	.5075	28 8	32.4	27.0	29.68	— 4.70	.144	.169	.121	.145	.90	.91	.82	.87	N N W	Calm.	Calm.	N 56 W	4.5	0.0	0.0	1.42	1.97	...	...
22	.446	.446	.591	.5047	30.6	34.5	29.8	31.45	— 2.63	.152	.148	.147	.146	.89	.75	.88	.83	W	N N W	N W	N 30 W	0.4	15.2	10.4	10.54	10.82	...	0.2
23	.723	.739	—	—	23.7	26.6	—	—	—	.112	.098	—	—	.87	.68	—	—	N W b N	W N W	W S W	N 80 W	7.1	13.5	9.5	10.92	12.11	...	0.1
24	.652	.645	.525	.5915	31.3	40.7	35 2	35.73	+ 2.47	.152	.180	.164	.165	.86	.70	.80	.79	W S W	S S W	S W	S 33 W	6.8	15.5	3.0	8.22	8.48	...	...
25	.468	.458	.475	.4720	39.2	43.2	36.3	39.40	+ 6.43	.216	.227	.185	.199	.90	.81	.86	.82	S	S W b S	Calm.	S 53 W	3.4	8.8	0.0	3.21	3.92	Inp.	...
26	.446	.452	.491	.4692	33.4	37.0	33 8	34.57	+ 2.00	.148	.159	.158	.154	.78	.72	.81	.77	W N W	N W b W	W b N	N 62 W	3.5	16.2	4.5	6.54	6.80	...	...
27	.453	.342	.272	.3480	33.1	33.1	29.8	31.82	— 0 37	.145	.145	.154	.147	.76	.76	.93	.81	W N W	W S W	S S W	S 34 W	6.8	6.5	1.8	5.32	6.41	...	3.0
28	.134	.139	.278	.1907	30.2	34.5	27.7	30.50	— 1.38	.149	.157	.121	.142	.89	.78	.80	.83	S W	S W b W	W S W	S 67 W	5.0	7.0	4.4	4.25	4.52	...	0.2
29	.352	.350	.477	.3970	26.2	33.8	31.3	30.85	— 0.65	.124	.173	.160	.154	.87	.89	.90	.89	N b E	S b W	S b W	S 43 W	5.0	0.5	0.4	0.74	1.81	...	0.6
30	.546	.496	—	—	32.0	33.4	—	—	—	.158	.163	—	—	.87	.85	—	—	W b S	W b S	N E	N 36 E	3.0	2.5	5.0	1.37	2.90	...	0.5
...	....	....	....	....	.....	......	......	... ..	....	......	......	......	......	.....	......	......	......	....	....	....	....	......	......	......	....	......	....	....
M	29.6316	29.6118	29.6529	29 6364	33.46	39.59	34.34	35.58	— 0.57	.167	.182	.169	.171	.85	.73	.83	.80	....	....	....	....	4.89	8.84	5.31	......	6.60	2.205	5.3

REMARKS ON TORONTO METEOROLOGICAL REGISTER FOR NOVEMBER, 1862.

Highest Barometer . . . . 30.469 at 10 a. m. on 15th. } Monthly range=
Lowest Barometer . . . . 29.132 at 8 a. m. on 28th. } 1.337 inches.
Self-registering Ther. { Maximum temperature . . . . 58°0 on p.m. of 1st } Monthly range=
Minimum temperature . . . . 16°2 on a.m. of 15th } 41°8
Mean maximum temperature . . 40°59 } Mean daily range=10°09
Mean minimum temperature . . 30°50 }
Greatest daily range . . . . 19°2 from a. m. to p. m. of 11th.
Least daily range . . . . 2°2 from a. m. to p. m. of 27th.
Warmest day . . . 1st ..Mean Temperature . . .=50°35 } Difference=27°55.
Coldest day . . . . 15th ...Mean Temperature . . .=22°80 }
Maximum { Solar . . . . 72°0 on p.m of 1st } Monthly range=
Radiation { Terrestrial . . . . 7°0 on a. m. of 15th } 65°.0
Aurora observed on 0 nights; possible to see Aurora on 8 nights; impossible on 22 nights.
Snowing on 11 days; depth 5.3 inches; duration of fall 51.0 hours.
Raining on 11 days; depth, 2.205 inches; duration of fall, 51.5 hours.
Mean of cloudiness=0.79; above the average, 0.05. Most cloudy hour observed, 2 p.m.; mean=0.82; least cloudy hour observed, 10 p.m.; mean=0.74.

Sums of the components of the Atmospheric Current, expressed in Miles.

North.	South.	East.	West.
2319.40	818.21	698.80	2252.95

Resultant direction, N. 46° W.; Resultant Velocity, 3.00 miles per hour.
Mean velocity 6.60 miles per hour.
Maximum velocity 26.6 miles, from 0 to 1 a.m. on 3rd.
Most windy day 2nd—Mean velocity 12.26 miles per hour. } Difference 10.45.
Least windy day 29th—Mean velocity 1.81 miles per hour. }
Most windy hour, 1 to 2 p.m.—Mean velocity, 9.36 miles per hour. } Difference
Least windy hour, 7 to 8 a.m.—Mean velocity, 4.50 miles per hour. } 4.86 miles.

1st. Dense fog 8 to 10 p.m.; lunar corona 9.30 to 11 p.m.—2nd. Solar halo during forenoon; thunderstorm 6 to 9 p.m.—4th. Perfect lunar halo 10 p.m and midnight.—5th. Lunar halo at 10 p.m.—6th. Lunar halo from 7.30 to 10.30 p.m.—7th. Solar halo during forenoon; lunar halo 7 to 8 p.m.—10th. Lunar corona at 6 a.m. —11th. Ground fog during the forenoon.—12th. Lunar halo 11 p.m. to midnight. —17th. Dense fog 6 to 8 a.m.

GREAT BAROMETRIC MOVEMENT.

November { 11th, 10 p.m. = 29.361 } Ascending range in 84 hours = 1.108 inches.
15th, 10 a.m. = 30.469 }
20th, 6 a.m. = 29.215—Descending range in 116 hours = 1.254 inches.

Movement in 200 hours..= 2.362 inches.

The month of November 1862 was comparatively cold, dry, calm and cloudy.

COMPARATIVE TABLE FOR NOVEMBER.

YEAR.	TEMPERATURE. Mean.	Excess above Average, (36°7).	Maximum observed.	Minimum observed.	Range.	RAIN. No. of days.	Inches.	SNOW. No. of days.	Inches.	WIND. Resultant. Direction.	Velocity.	Mean Velocity
1840	° 35.9	— 0.8	° 54.4	° 20.5	° 33.9	5	1.220	8	...	...	...	...
1841	35.0	— 1.7	63.2	7.6	55.6	8	2.450	5	...	...	...	0.91lbs
1842	33.3	— 3.4	50.6	7.6	43.0	9	5.310	10	...	...	...	1.22 "
1843	33.5	— 3.2	51.2	14.4	36.8	10	4.765	7	1.2	...	...	0.59 "
1844	34.9	— 1.8	49.8	12.0	37.8	8	Imp.	4	8.0	...	...	0.48 "
1845	36.8	+ 0.1	58.8	7.6	51.2	7	1.105	4	5.0	...	...	0.53 "
1846	41.3	+ 4.6	55.5	18.2	37.3	12	5.805	2	0.4	...	...	0.64 "
1847	38.6	+ 1.9	58.2	7.8	50.4	14	3.155	3	Inp.	...	...	0.36 "
1848	34.5	— 2.2	49.3	16.5	32.8	9	3.020	3	1.4	N 81 W	1.81	4.81ms.
1849	42.6	+ 5.9	56.7	28.4	28.3	10	2.815	2	1.0	N 39 W	1.55	4.78 "
1850	38.8	+ 2.1	62.3	18.1	44.2	7	2.955	1	Inp.	N 42 W	1.43	5.27 "
1851	32.9	— 3.8	50.1	16.5	33.6	5	3.885	6	6.7	N 50 W	1.25	4.70 "
1852	36.0	— 0.7	50.4	18.7	31.7	7	1.775	3	2.0	N 59 W	1.53	6.50 "
1853	38.7	+ 2.0	54.1	14.4	39.7	15	2.425	6	2.7	N 9 W	0.55	5.52 "
1854	36.8	+ 0.1	54.9	15.1	39.8	13	1.115	4	1.3	W	3.44	7.54 "
1855	38.6	+ 1.9	54.1	18.7	35.4	8	4.590	6	3.0	N 66 W	3.18	10.81 "
1856	37.4	+ 0.7	56.4	22.8	33.6	10	1.375	9	9.5	S 85 W	2.95	8.75 "
1857	33.5	— 3.2	57.8	—2.3	60.1	14	3.235	9	6.9	S 61 W	5.45	9.25 "
1858	34.2	— 2.5	52.0	20.5	31.5	12	3.879	13	4.0	N 25 W	3.14	8.87 "
1859	38.9	+ 2.2	61.0	24.1	36.9	12	5.193	9	0.6	N 81 W	3.39	9.65 "
1860	37.9	+ 1.2	62.7	14.0	48.7	12	2.569	8	1.9	S 89 W	4.95	11.02 "
1861	37.1	+ 0.4	51.5	25.1	26.4	14	4.294	8	3.2	N 46 W	1.94	7.44 "
1862	35.6	— 1.1	58.0	17.2	40.8	11	2.205	11	5.3	N 46 W	3.00	6.60 "
Results to 1861.	36.69	...	55.23	15.74	39.49	10.0	3.140	5.9	3.10	N 76 W	2.29	7.49
Exc. for 1862.	—1.11	...	+ 2.77	+ 1.46	+ 1.31	+ 1.0	— 0.935	+ 5.1	+ 2.20	...	...	—0.89

MONTHLY METEOROLOGICAL REGISTER, ST. MARTIN, ISLE JESUS, CANADA EAST—AUGUST, 1862.

(NINE MILES WEST OF MONTREAL.)

BY CHARLES SMALLWOOD, M.D., LL.D.

Latitude—45 deg. 32 min. North. Longitude—73 deg. 36 min. West. Height above the Level of the Sea—118 feet.

Day.	Barom. corrected and reduced to 32°			Temp. of the Air.—F.			Tension of Vapour.			Humidity of Air.			Direction of Wind.			Horizontal Movement in Miles in 24 hours.	Mean of Ozone.	Rain in inches.	Snow in inches.	WEATHER, &C. A Cloudy sky is represented by 10; A cloudless sky by 0.		
	6 A. M.	2 P. M.	10 P. M.	6 A. M.	2 P. M.	10 P. M.	6 A. M.	2 P. M.	10 P. M.	6 A. M.	2 P. M.	10 P. M.	6 A. M.	2 P. M.	10 P. M.		t'nths			6 A. M.	2 P. M.	10 P. M.
1	29.914	29.894	29.831	60.1	85.1	72.0	.456	.775	.601	.88	.65	.78	N E b E	N E b E	s b E	60.00	2.0	...	...	Hazy.	Cum. Str. 2.	C. Cirr. Str. 2.
2	794	753	832	60.1	89.9	68.5	456	894	642	88	64	92	w s w	s w	s b w	22.80	2.5	...	...	Fog.	C. C. Str. 6.	Clear.
3	853	818	814	65.1	92.0	73.3	583	768	617	94	51	77	s b E	s s w	s s w	2.80	2.5	...	...	Do.	Cu. Str. 4.	Str. 2.
4	797	748	832	68.1	93.6	76.5	543	755	765	79	48	84	s b w	s b E	s w	64.20	1.0	...	...	Cirr. 2.	Clear.	Hazy. AurBor.
5	680	615	724	70.1	89.0	70.1	592	802	557	83	57	77	s b w	s s w	N N E	142.70	2.0	...	...	Cirr. Str. 2.	C. C. Str 4.	Clear.
6	863	859	796	61.1	79.2	64.3	396	658	563	79	67	94	N N E	N N E	N N E	56.50	1.5	...	...	Clear.	Cirr. 2.	Cu. Str. 4.
7	30.005	886	830	57.6	89.1	69.6	378	992	572	81	64	72	E b N	s s E	s s E	51.00	2.0	...	...	Do.	C. C. Str. 4.	Rain.
8	29.641	646	831	61.1	79.8	72.1	480	850	631	91	85	81	s w	s s w	s w	166.80	2.0	0.503	...	Cu. Str. 10.	C. Cum. 4.	Clear. AurBor.
9	627	514	469	63.7	89.9	73.0	409	942	624	70	68	79	w b N	s s w	w s w	99.70	1.0	...	...	Clear.	Cu. Str. 2.	Do.
10	382	735	779	68.9	85.6	69.3	510	643	485	75	48	72	s s E	s w	w	96.30	1.0	...	...	Cirr. Str. 10.	Clear.	Do.
11	745	796	624	62.4	88.4	72.1	376	778	496	69	59	64	s w	s w	s w	90.20	1.5	...	...	Clear.	Do.	Cu. Str. 8.
12	585	714	866	68.3	81.6	57.0	457	738	357	69	69	78	s w	w	w b s	280.80	1.0	...	...	Clear. [Dis.Th.	C. Cum. 4.	Clear.
13	983	885	921	51.4	78.3	60.2	252	588	374	68	62	73	w	s w	s w	1.00	1.0	...	...	Do.	Clear.	Str. 4. AurBor.
14	730	667	646	56.4	75.7	64.2	336	484	497	75	56	88	s w	s w	s w	137.50	2.0	...	...	C. C. Str. 10.	Cu. Str. 10.	Rain.
15	666	645	706	48.1	73.2	59.0	285	624	439	85	70	88	s w	w b N	w	295.60	2.5	0.161	...	Cirr. Str. 10.	Do. 4.	Cirr. Str. 10
16	899	875	957	49.2	71.1	54.2	272	509	308	78	68	74	w	w	w	139.90	1.0	...	...	Clear.	C. C. Str. 4.	Clear.
17	30.101	30.094	30.056	43.1	74.2	61.6	209	376	406	75	47	74	w s w	w s w	s w	56.40	1.5	...	...	Light Frost.	Clear.	Do.
18	29.900	29.857	29.751	51.4	79.2	63.0	270	612	278	72	62	83	s w	s w	s w	39.60	1.5	Inap.	...	C. C. Str. 4.	C. C. Str. 8.	CuStr4. AurB.
19	797	30.000	830	61.8	78.2	64.0	390	626	464	74	65	77	s w	s w	s w	63.20	1.0	...	...	Clear.	Clear.	Clear. AurBor.
20	841	29.853	928	60.4	82.2	65.1	426	610	483	82	56	78	s w	s w	N b E	84.20	1.5	...	...	Do.	C. C. Str. 8.	Cu. Str. 10.
21	962	860	928	51.4	71.6	64.1	296	365	464	79	47	77	N E b E	N E b E	s b w	126.70	2.0	0.160	...	C. C. Str. 10.	Cu. Str. 4.	Clear SolHalo
22	656	541	588	60.1	69.2	70.1	487	635	537	94	90	77	N E b E	N E b E	s b w	149.10	3.0	0.601	...	Rain.	Rain.	Do. CometVis
23	566	30.100	922	64.2	74.6	53.3	464	577	251	77	64	68	w	s w	w b N	252.24	2.0	Inap.	...	Cum. Str. 4.	Cum. Str, 10.	Clear.
24	30.140	110	30.077	43.8	74.1	54.2	209	396	314	75	48	86	w b N	s w	s w	82.40	1.5	...	...	Frost.	Clear.	Do.
25	29.918	29.780	29.725	47.2	77.2	70.1	273	689	516	85	69	70	s w	s w	s w	134.60	1.0	...	...	Do.	Do.	Cu. Str. 10.
26	691	644	710	67.9	77.2	67.8	516	689	556	77	69	84	s b w	s b w	s w	61.20	1.5	Inap.	...	C. C. Str. 10.	Rain.	C. C. Str. 4.
27	760	730	731	52.1	76.2	54.2	334	577	308	86	64	74	N E b E	N E b E	s b E	72.50	1.5	...	...	Cu. Str. 4.	Clear.	Clear.
28	604	513	446	60.2	72.1	62.2	456	631	449	88	81	85	s E	s b E	s b E	10.00	1.0	Inap.	...	C. C. Str. 10.	Cirr. Str. 10.	Cu. Str. 4.
29	625	698	750	51.1	60.3	53.0	296	255	321	79	49	80	w b N	w b N	w b N	310.40	1.0	...	...	Clear.	Do. 4.	Do. 4. AurBor
30	30.039	30.010	971	40.1	70.0	56.2	182	516	363	73	70	81	w b N	s w	s w	140.40	1.5	...	...	Frost.	Clear.	Clear.
31	29.887	29.806	654	52.0	80.6	62.2	315	711	429	83	68	77	s w	s w	s w	155.00	1.5	...	...	Clear.	Do.	Do.

MONTHLY METEOROLOGICAL REGISTER, ST. MARTIN, ISLE JESUS, CANADA EAST—SEPTEMBER, 1862.

(NINE MILES WEST OF MONTREAL.)

BY CHARLES SMALLWOOD, M. D., LL.D.

Latitude—45 deg. 32 min. North. Longitude—73 deg. 36 min. West. Height above the Level of the Sea—118 feet.

Day.	Barom. corrected and reduced to 32°			Temp. of the Air.—F.			Tension of Vapour.			Humidity of Air.			Direction of Wind.			Horizontal Movement in Miles in 24 hours.	Mean of Ozone. (tenths)	Rain in Inches.	Snow in Inches.	WEATHER, &c. A cloudy sky is represented by 10; A cloudless sky by 0.		
	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.					6 A.M.	2 P.M.	10 P.M.
1	29.346	29.204	29.214	60.1	64.2	63.2	.487	.529	.543	.94	.89	.94	s w	s w	s w	201.90	3.0	0.976	...	Rain.	Rain. Dis.th.	Rain.
2	347	564	797	49.1	55.2	45.2	.297	.263	.206	.85	.64	.69	s w	w	w b N	325.58	1.5	...	...	Cu. Str. 8.	Cirr. Str. 4.	Clear. AurBor.
3	892	896	30.022	40.1	66.1	54.0	.203	.438	.385	.82	.68	.80	w b N	w b N	w	63.20	1.5	...	...	Frost.	Clear.	Do. [at 2 a.m.
4	902	820	29.830	50.0	83.4	70.4	.290	.597	.586	.82	.53	.80	s w	s	s w	109.40	1.0	...	...	C. C. Str. 9.	Cu. Str. 8.	Do.
5	821	772	840	70.2	77.2	70.1	.592	.841	.621	.83	.91	.85	s w	s w	w	116.60	2.0	In'p.	...	C. Cum 4.	Rain.	Do.
6	811	798	890	57.1	57.7	54.0	.436	.459	.396	.94	.97	.96	N E b E	N E b E	s E b E	237.20	3.0	1.261	...	Rain.	Do.	Rain.
7	727	656	710	47.4	66.2	61.1	.311	.509	.449	.93	.81	.85	N E b E	N E b E	s b E	92.20	2.0	0.130	...	Cu. Str. 10.	C. C. Str. 10.	Cu. Str. 9.
8	649	534	611	69.2	81.0	63.2	.671	.751	.478	.95	.72	.83	s E	s w	w	202.90	2.5	0.587	...	Rain.	Cu. Str. 4.	Clear.
9	937	999	30.037	58.1	72.4	56.0	.400	.631	.363	.84	.81	.81	w	w	s w	203.10	1.0	...	...	Clear.	Clear.	Do. Aur. Bor
10	30.047	30.019	025	50.2	79.7	68.2	.290	.606	.577	.82	.60	.85	s w	s w	s w	18.60	1.0	...	...	Do.	Do,	Do.
11	29.984	29.904	29.868	50.1	84.7	67.2	.309	.577	.496	.85	.49	.77	s w	s w	s b w	7.50	1.5	...	...	Do.	Do.	Do.
12	747	720	816	65.1	74.1	62.1	.549	.436	.491	.89	.53	.88	s b w	s b w	N N E	136.50	1.5	0.110	...	C.Cirr.Str.4.	Rain.	Cum. Str. 8.
13	904	30.014	30.134	60.4	63.4	50.0	.396	.356	.283	.76	.53	.78	N E b E	N E b E	N E b E	249.40	1.0	...	...	Clear.	Clear.	Clear.
14	30.241	150	050	45.2	69.1	54.2	.251	.543	.335	.84	.79	.80	N E b E	s E	s E	68.50	1.0	...	...	Cirr. Str. 10.	Str. 2.	Do.
15	29.938	29.954	29.963	54.1	64.0	53.0	.335	.497	.321	.80	.83	.80	s w	s w	s w	0.80	2.0	0.304	...	C. C. Str. 4.	Rain.	Do.
16	30.050	30.000	30.004	45.0	66.1	53.0	.251	.400	.328	.84	.61	.83	s w	s w	s w	6.80	1.5	...	...	Clear.	Clear.	Do.
17	29.951	29.964	29.976	42.0	68.4	56.3	.244	.443	.391	.91	.65	.87	s w	s w	N E b E	102.80	1.5	...	...	Fog.	Do.	Do.
18	704	575	700	56.7	71.3	69.1	.398	.537	.571	.90	.71	.82	s w	s w	s w	139.20	1.0	...	...	Cu. Str. 4.	Cu. Str. 10.	Do.
19	736	785	937	64.0	70.9	59.2	.490	.571	.410	.81	.84	.82	s w	s w	s w	66.10	1.5	In'p.	...	C. C. Str. 8.	C. Cum. 4.	Do. Ft.AuBor.
20	970	940	816	39.1	79.4	63.0	.195	.886	.491	.82	.87	.88	s w	s w	s w	19.90	1.5	...	...	Clear.	Clear.	Do.
21	913	30.027	30.106	48.1	72.0	50.2	.285	.493	.290	.85	.64	.82	s w	s w	s w	24.10	1.0	..	...	Do.	Do.	Do.
22	30.047	29.910	29.926	42.1	78.2	62.1	.222	.671	.466	.83	.71	.85	s b E	s w	s w	11.10	2.0	...	...	Do.	Do.	Do.
23	29.870	675	580	44.4	86.2	68.4	.202	.557	.543	.74	.54	.79	s s w	s b w	s w	36.90	1.5	...	...	Do.	Do.	Do.
24	612	739	839	54.2	65.6	45.0	.341	.542	.258	.83	.87	.88	w	w	w	116.20	2.5	0.164	...	Rain.	Cu. Str. 4.	Do. Ft.AuBor.
25	430	789	832	44.2	67.9	56.0	.224	.431	.391	.79	.66	.87	w	s w	s w	30.30	1.0	...	...	C. C. Str. 10.	Clear.	Do. do.
26	819	797	863	45.1	73.0	60.1	.223	.476	.439	.76	.59	.88	s	s w	s w	103.40	1.5	...	...	Clear.	Do.	Do. do.
27	855	847	861	57.0	83.4	64.0	.413	.597	.497	.90	.53	.83	s w	s w	s w	148.19	1.0	...	...	Do.	Do.	Do. Aur. Bor.
28	805	712	741	54.1	78.6	64.2	.362	.619	.497	.87	.64	.83	s w	s w	s w	10.70	1.5	...	...	Cu. Str. 10.	Cirr. Str. 10	Do. Ft.AuBor.
29	704	654	842	56.0	66.6	54.1	.398	.463	.362	.90	.71	.87	s w	N E b E	N E b E	39.30	1.5	...	...	Do. 4.	C. C. Str. 10.	Cu. Str. 8.
30	972	978	30.071	39.1	44.2	34.0	.261	.157	.162	.91	.55	.87	N E b E	N E b E	s b E	105.90	2.5	...	...	Cirr. Cum. 4.	Do. 4.	Clear.
...	......	......	......	......	......	......	......	......	......	...	...	...	....	....	....	....	...	......	...	....	....	....

REMARKS ON THE ST. MARTIN, ISLE JESUS, METEOROLOGICAL REGISTER FOR AUGUST, 1862.

Barometer	Highest, the 24th day	30.140
	Lowest, the 28th day	29.446
	Monthly Mean	29.792
	Monthly Range	0.694
Thermometer	Highest, the 4th day	93°.6
	Lowest, the 24th day	34°.0
	Monthly Mean	65°.61
	Monthly Range	59°.6
Greatest intensity of the Sun's Rays		105°.3
Lowest Point of Terrestrial Radiation		31°.2
Mean of Humidity		.727
Amount of evaporation		2.97

Rain fell on 9 days, amounting to 1.425 inches; it was raining 15 hours and 40 minutes.

Most prevalent wind, the S. W.

Least prevalent wind, the N. b E.

Most windy day, the 29th; mean miles per hour, 12.92.

Least windy day, the 13th; mean miles per hour, 0.04.

Aurora Borealis visible on 6 nights.

Comet Visible.

The Electrical state of the Atmosphere has indicated moderate intensity.

Temperature of Thermometer in ground, 65°.0.

Solar Halo on the 21st day.

Frost on 4 mornings.

REMARKS ON THE ST. MARTIN, ISLE JESUS, METEOROLOGICAL REGISTER FOR SEPTEMBER, 1862.

Barometer	Highest, the 14th day	30.241
	Lowest, the 1st day	29.204
	Monthly Mean	29.833
	Monthly Range	1.037
Thermometer	Highest, the 14th day	84°9
	Lowest, the 3rd day	32°2
	Monthly Mean	59°48
	Monthly Range	52°7
Greatest intensity of the Sun's rays		98°0
Lowest point of Terrestrial Radiation		30°1
Mean of Humidity		.791
Amount of evaporation		1.86

Rain fell on 9 days, amounting to 3.532 inches; it was raining 64 hours.

Most prevalent wind, S.W.

Least prevalent wind, S.

Most windy day, the 2nd day; mean miles per hour, 13.59.

Least windy day, the 15th day; Inapp.

Aurora Borealis visible on 9 nights.

Temperature of the ground at 18 inches, 63°.2.

The Electrical state of the Atmosphere has indicated feeble intensity.

⁂ In consequence of the removal of the Observatory from St. Martin's to Montreal, the report for September will close the series of observations taken there. Full reports of the observations taken at the *Montreal Observatory* will be furnished, as soon as it is placed in working order.

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VI. *Mathematics and Natural Philosophy:* J. B. Cherriman, M. A., Prof. of Natural Philosophy, Univ. Coll., Toronto; and the Rev. G. C. Irving, M.A., Prof. of Mathematics, Trin. Coll., Toronto.

VII. *Engineering and Architecture:* Sandford Fleming, C. E.

VIII. *Philology:* Rev. E. Hatch, B.A., Prof. of Classics, Morin Coll., Quebec.

⁂ *Communications to be addressed to the General Editor,* Prof. Cherriman, *Univ. Coll.. Toronto.*

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THE CANADIAN JOURNAL.

NEW SERIES.

No. XLIV.—MARCH, 1863.

THE PRESIDENT'S ADDRESS.

BY THE REV. JOHN M^cCAUL, LL.D.,
PRESIDENT OF UNIVERSITY COLLEGE, TORONTO.

Read before the Canadian Institute, January 10*th*, 1863.

Gentlemen of the Canadian Institute,—

In opening the proceedings of a new year of the Society's existence with the customary address, my first duty is to return thanks for the honour which you have conferred upon me, by your unanimous election of me as President of the Institute. Whilst I highly appreciate this mark of your estimation, I must confess that when I received the official notification of our Secretary, I had some hesitation as to the propriety of my accepting the office, for I was conscious that it would be impossible for me to discharge the duties with that regularity which you might expect, and which I myself would desire. In other Societies, in which I have held a similar position, I have endeavoured, if prevented by my avocations from lending active co-operation, at all events to give assistance by punctuality of attendance at their meetings. In the case of the Canadian Institute, however, as its season extends over precisely that period of the year, when my duties are most heavy, and my engagements most pressing, I could not hope to be able to give even that proof of the interest, which I feel in its welfare. Whilst I was still doubting on this point, I had the opportunity of ascertaining the views of some of our members, who have taken a most active part in promoting the welfare of the Institute, and they assured me that such uniformity of attendance, as I believed to be necessary for the satisfactory discharge of the duties, was not indispensable. Influenced by these assurances, and confiding in the aid of my able colleagues, the Vice-Presidents, I accepted the office with which you have honored me, with the determination to discharge the duties to the best of my ability, and with the persuasion, that any necessary shortcomings would receive considerate indulgence at your hands.

The commencement of a new year suggests to Societies, as well as to individuals, the expediency of taking a retrospect of that which has just passed away, and of considering what they, and what others, in a like position, or engaged in similar pursuits, have done during the past twelve months. Following out this suggestion, I purpose submitting a brief review of the progress which has been made, during the year 1862, in those departments of human knowledge, which it is the object of this Institute to cultivate. In attempting this summary, it is scarcely necessary for me to premise that it must necessarily be very imperfect. The brief fortnight which has elapsed since I was unexpectedly called upon to prepare an Inaugural Address—the shortness of time, suitable for observations, on such an occasion as the present, which imposes cramping restraint in treating so extensive a subject—the vast number of particulars which solicit attention—and my own inability to handle all the branches, of which I must necessarily treat, with the skill, or ease, or confidence, that almost nothing but special attention to each can bestow,—all these compel me to give but the merest outline, and to select from the mass of materials, only those which, as it were, crop out on the surface.

The construction of star charts, those invaluable aids to the practical astronomer, is still in progress by Argelander of the Bonn Observatory and Chacornac of the Paris Observatory. In the volumes, which have been recently published by the former distinguished astronomer, the approximate places are given of 216,000 stars between the parallels of 2° South Declination, and 41° North Declination. This magnificent work is intended to be an Atlas of the stars of the Northern Heavens within 92° of polar distance. An important result of the publication of these charts has been that they have greatly facilitated the discovery of the small planets or asteroids between the orbits of Mars and Jupiter. Since 1859 no fewer than twenty of these remarkable bodies have been discovered, so that their number at the close of last year was seventy-six.

The investigations of the motion of Sirius by Bessel and Peters had revealed some irregularities in right ascension, and Bessel had surmised that they were due to the influence of some unknown body in the vicinity of the star. This companion, whose existence had not been ascertained by sight, was discovered on Jan. 31, by Mr. Clark of the U. S., with his new achromatic glass, and was subsequently observed by Prof. Bond at the Observatory of Harvard College. We have thus another most interesting example of the wondrous power of mathematical research to reveal that latent cause of perturbation, which the keenest vision, aided by the most powerful instruments, had previously failed to detect. It is proper, however, that I should add that Dr. Peters does not accept the identity of this stranger with that which he had computed.

In accordance with the suggestion of Sir John Herschel, made about eight years ago, relative to the advantages of taking daily photographs of the sun, a new and valuable instrument was invented, the Photoheliograph, or rather, as the name has been emended, the Heliautograph. At the last meeting of the British Association for the advancement of Science, Prof. Selwyn exhibited a series of those wonderful portraits taken by the sun of himself. They represent the progress of the spots with their *penumbræ* as the sun revolves on his axis, and the *faculæ* or bright streaks which accompany those spots. On the same subject Mr. Nasmyth stated his observations relative to the three luminous strata—which envelope the sun—the mist envelope—the penumbral stratum—and the external, in which the lenticular, or, as they are called, the willow leaf structures are found. Photography has also been successfully applied to the moon, and Mr. De la Rue's skilful manipulation has produced most accurate representations.

At the same meeting, Prof. Challis communicated a paper on the terrestrial atmosphere, which he regarded as definitely limited, and balloon ascents were noticed as a probable mode of furnishing approximations for its actual height. Previously to this the most remarkable ascent on record had been made by Messrs. Glaisher and Coxewall, in which the astonishing altitude of 35,000 or 36,000 feet was gained, not, however, without the most imminent risk to the aeronauts. In reading the very interesting account of this ascent, we cannot contemplate without admiration the coolness with which one of the adventurers continued his scientific observations until at length at some five or six miles above the surface of the earth, he lost all power of eyes and limbs, and fell back in the car as in sleep, and the presence of mind with which his companion, when his hands had failed him, "seized the line between his teeth and pulled the valve open until the balloon took a turn downward," and the numbed observers were thawed into consciousness.

During the past year two comets have been visible—one by computation only nine millions of miles from the earth. The other, and the more remarkable of the two, continued within the circle of perpetual apparition for five weeks, but when nearest to the earth was distant thirty-three millions of miles.

In connexion with this subject, I have pleasure in calling attention to a magnificent volume, giving a full account of the great comet of 1858, by Mr. Bond, Director of the Observatory of Harvard College. This is, so far as I am aware, the most complete work on the subject that has ever been published.

The government of Ecuador have offered to the French government the site for an observatory on the plateau of Durito. This locality presents almost unequalled advantages for observation from its position on the globe, and from the remarkable clearness of the atmosphere. The parallax observations, which have been made during the past year, taken in connexion with Foucault's experiments on the velocity of light, and Struve's measurement of an arc of parallel, promise the most important results relative to the question of the sun's distance.

But little calling for special notice, on such an occasion as the present, has been done during the year in pure mathematics, but a most remarkable example, illustrating their beauty and their power as applied to constructive mechanics, has been presented by the explanation given by the Astronomer Royal, of the directions and magnitudes of the strains on the sides of tubular bridges. It must be most gratifying to Prof. Airy to find that his theory was accepted not only by mathematicians, who admired the skill with which he produced the equations and the ingenuity with which he rendered them manageable, but also by practical men, such as Mr. Fairbairn and

Mr. Russell, who recognized the precise agreement of the theory with experiment. It is important to add, that the lines of strain as pointed out by him were regarded as bearing some relation to the lines of polarization and depolarization produced by strained glass.

As I have adverted to Mechanical Science, I cannot pass from the subject without noticing an admirable application of siphons by Mr. Appold, which seems to surpass steam-pumping both in efficiency and in economy. The air is exhausted from the siphons by a small engine, which works air pumps, and the quantity of water discharged by six siphons was no less than 50,000 gallons a minute.

Nor should I omit noticing Mr. Peter's most wonderful machine for microscopic writing, the working of which seems almost incredible. "Within a circle of the three-hundredth of an inch, about the size of a transverse section of a human hair, the Lord's Prayer can be written so as to be legible ; and a calculation has been made that with this machine the entire Bible might be written twenty-two times in the space of a square inch."

In an examination, which I lately saw somewhere, of the sums expended by the British Association for the advancement of Science, I observed a complaint that so small an amount, less than a tenth I believe, was spent for the encouragement and promotion of the important department of Chemistry. The want of this pecuniary aid, however, does not seem to have produced any injurious consequences, for there can hardly be a more satisfactory practical proof of the success with which this branch has been cultivated during the past year than the fact that three out of the four medals of the Royal Society were awarded for chemical researches. A notice of these investigations will, probably, be the most satisfactory review which I can present of the progress of chemical science during the past year. The Copley Medal was awarded to Mr. Graham, Master of the Mint, for his discoveries in the employment of the diffusion of liquids in chemical analysis, or, as he terms the process of separation, *dialysis*. Compound substances are by him distinguished into *colloids* and *crystalloids*, and thees forms are regarded, the former as the dynamic, the latter as the statical form of matter. The importance of the results attainable by this new method justifies our ranking Graham with Dalton and Davy in the advancement of Chemical Science.

The Rumford Medal was awarded to Professor Kirchoff of Heidelberg, as a just recognition of his remarkable researches in Spectral analysis. What a wonderful example is presented, in this most beautiful and valuable discovery, of the progress of human knowledge! About two hundred years ago Sir Isaac Newton astonished the scientific world by the discovery of the composition of solar light, and for many years it was a favorite optical experiment to produce the spectrum by a prism, and prove the variety of the tints that are combined in what had been regarded as simply white light. Just sixty years have elapsed since Wollaston added to our knowledge of the spectrum by the discovery of the seven dark lines. The subject thus commenced in England was taken up by Fraunhofer who observed no less than 590 of these lines, and since his time the number has been increased by the researches of Brewster and Gladstone to about 2000. In Kirchoff's experiments five prisms were used, and he has succeeded in producing an exact map giving the distances, the breadth, and the degree of darkness in the lines. But this is not all. With a similar instrument he and Professor Bunsen examined the spectra of the chemical elements, and the application of this new mode of analysis has already resulted in the addition of three new metals. But the most astonishing of Kirchoff's discoveries is the detection of sodium, nickel, barium and copper in the solar atmosphere. The process has also been applied to the fixed stars and Donati has compared the refractive powers of stellar and solar light.

When we consider the magnitude of these sublime discoveries and the variety of their probable results, we cannot but look with admiration and with gratitude on the wondrous powers of the human intellect—that mighty instrument with which our Almighty creator has equipped us. With it we have bound the hostile elements, fire and water, in amity together and have yoked them in iron harness to execute our will; with it we have descended into this globe of ours; classed its stratifications; analyzed its natural history; investigated its age; and even ventured to pourtray, in ideal sketches, the principal features of the primæval landscape: with it we have explored the depths of ocean and laid down the elevations and depressions of its bed in charts of submarine geography: with it we have ascended into heaven and mapped down the courses of the bright luminaries that stud its vault: with it we have brought under our cognizance the composition of the physical source of light, and are able to pronounce, with the certainty of Science, on the constituent elements of a body 95,000,000 of miles removed from us, through the aid of an analysis so subtle that on this earth it detects the 100,000,000th portion of a grain. Well may we exclaim in those words which are each year receiving further confirmation and development:—" What is man that thou art mindful of him? and the Son of man that thou visitest him? For thou hast made him a little lower than the angels and hast crowned him with glory and honour. Thou madest him to have dominion over the works of thy hands; thou hast put all things under his feet."

Of the remaining two medals of the Royal Society one was awarded to Professor Williamson for his researches in compound ethers, and his establishment of the correctness of the theory of types, as foreshadowed by Mr. Sterry Hunt of the Canadian Survey, and now almost universally adopted by chemists.

The benefits of the inter-communication afforded by the electric telegraph are being rapidly extended all over the earth, and so many links of the chain destined yet to gird the world have been completed, that messages on ordinary business are now transmitted over 4000 or 5000 miles. Hopes are entertained, and not without reason, that the old and the new worlds will soon be connected by a line more durable and more secure than that which a few years ago raised expectations that were so soon disappointed. Nor should I omit mentioning, whilst adverting to the subject, that amongst the astonishing notices of discoveries of the past year is one, apparently trustworthy, that electric signals are now transmitted without any artificial conductors.

Before I pass on from this most interesting and important field of scientific research, let me briefly notice the remarkable manufacture of artificial stone by Mr. Ransome. The material consists of " any kind of mineral fragments, sand, limestone or clay, mixed into paste by a mould with fluid silicate of soda, and afterwards dipped into a solution of chloride of calcium."

At the progress of knowledge in the Natural Sciences—Mineralogy and Geology, Zoology and Botany,—I can take but a passing glance.

The Surveys which have been carried on both in Europe and on this continent, have greatly extended our acquaintance with the crust of the earth, and no inconsiderable advancement of our knowledge may be expected from the new science of Seismology.

A notable addition to Palæontology has been made by the discovery of a bird in the oolitic slate of Solenhofen, the most ancient ornithic specimen of which we possess any certain evidence. Professor Owen has given a description of it, characterised by his usual acumen. He had proposed *Griphornis* as a name for the creature, but he has abandoned it in favor of *Archæopteryx* of Von Meyer.

For nine years a committee of the British Association have been engaged in experiments on the preservation of vegetative power in seeds. They have established the fact that "the greatest age at which the seeds experimented upon were found to vegetate was about forty years." Much progress has been made in acclimitization; the introduction of the eland into England has succeeded—that of camels into this continent is regarded as promising, and already the warbling of the feathered songsters of Europe has been heard in the Australian woods.

The gorilla controversy so far as it relates to the credibility of M. Du Chaillu may be regarded as set at rest. Mr. Reade, after five active months in the country the habitat of the creature, asserts "that he is in a position to state that M. Du Chaillu shot neither leopards, buffaloes, nor gorillas; that the gorilla does not beat his breast like a drum; that the *Kulukambu* does not utter the cry of *Kooloo* or anything like it; that the young gorilla in captivity is not savage; and that while M. Du Chaillu affects to have been "a poor fever-stricken wretch" at Camma, he was really residing in robust health at the Gaboon." Mr. Reade, however, adds that he "must do M. Du Chaillu the justice to confess, that from the same sources that afforded me proof of his impostures, I learn that he is a good marksman; possessed of no common courage and endurance; that he has suffered many privations and misfortunes of which he has said nothing; that his character as a trader has been unjustly blemished; that his labours as a naturalist have been very remarkable; and that during his residence in Africa he won the affection of the natives and the esteem of those who most merit to be esteemed—the missionaries." Mr. Reade's communication ends with the just and generous expression of his regret "as a fellow-laborer though an humble one, that, actuated by a foolish vanity or by ill advice, he should have attempted to add artificial flowers to a wreath of laurels which he had fairly and hardly earned."

Another and a more important controversy relative to the gorilla has arisen between Prof. Owen and Prof. Huxley, extending to the general consideration of the differences in the structure of the brain between man and anthropoid apes. The question discussed by these eminent anatomists has been ably treated by Dr. Wagner, with reference to their views and those of Gratiolet, in an article which appeared in the *Archives of Natural History* in 1861.

In Geographical researches, much has been done during the last year. Within the first twelve months after the concession of the right of travelling with a passport through China, no fewer than twelve of the eighteen provinces have been visited by British subjects,—the great Yangtze has been traced through 1800 miles of its course,—and seven other journeys have been made by English explorers through portions of the Celestial Empire, hitherto unknown to Europeans. In Africa Speke, Petherick, Livingstone, Le Jean, and Von der Decken, have extended the limits of our knowledge. The continent of Australia has lately been traversed for the third time, happily without any such disastrous result to the adventurous explorers, as attended the expedition under the command of the gallant O'Hara Burke. In the Arctic regions Mr. Hall of Cincinnati, has discovered that Frobishers Strait is really a bay; he has also minutely examined a tract in N. Lat. 62° 52′, W. Long. 65° 05′, which seems not to have been visited or seen by any white man for almost 300 years.

Of all the expeditions which have been undertaken during the last year, probably the most remarkable, is that which proceeded in the spring under the Duke of Saxe-Coburg, with the object of exploring Central Africa. The party included the Duchess and another lady, two Princes, a physician, a litterateur, a painter, a linguist and a numerous retinue. This is doubtless the first Ducal progress with such a suite that has ever been attempted in a field so unpromising for comfort or security. In the Ethnological investigations, which have been prosecuted during the year, although but few positive results have been arrived at, much valuable material has been collected by the careful examination of *crania*, and by a more scientific analysis of language in accordance with the principles applied by Müller. The questions raised by the discovery of implements in the drift, and of human bones with those of extinct animals, have not yet been brought to a satisfactory issue. The remarkable fact seems worthy of notice, that so far no human remains have been found with the implements in the drift. To the works illustrative of this science, an important addition has recently been made by the publication of two volumes by one of our own members. The value of Dr. Wilson's "Prehistoric Man, or Researches into the Origin of Civilization in the Old and New

World," has been recognized by other labourers in the same sphere of enquiry.

The most important discovery during the year, in its bearings on History, is that of the Assyrian canon by Sir Henry Rawlinson. In searching through the collection of antiquities in the British Museum, he found some fragmentary tablets containing lists of eponymes or high priests, who gave their name to the year. Of this canon four versions have been found, and the application of the information thus derived, relative to the period between the 7th and 8th centuries, before Christ, cannot fail to be most interesting and valuable, especially as it may be used in illustration of Biblical History and Chronology. I regret to observe, that from the English periodicals it appears that an alienation of feeling has arisen from this discovery, between Rawlinson and that acute and profound scholar, Hincks. Let us earnestly hope that this estrangement will soon pass away, and that they will be found again working together in investigations so honourable to themselves and so beneficial to their fellow-men.

In Archæology, judicious excavations have revealed some most important memorials of the past. Under the careful superintendence of Fiorelli, many houses have been opened in Pompeii, and numerous most interesting remains have been discovered. It is much to be desired, that the work which has been entered upon under such good auspices, may be continued until the whole town is exhumed.

At Rome, excavations in different parts of the city have been made, and the results have been in some cases so satisfactory, that it may be hoped that some *quæstiones vexatæ* that have troubled Topographical Antiquarians will at last be settled. Some sculptures, especially a statue of remarkable excellence, have been found in the explorations in the Palatine, conducted at the expense of the Emperor of the French. But the most important discovery has been that of the original Church of St. Clement on the Esquiline, for which archæologists are indebted mainly to the Prior of the Irish Dominican College in the adjoining Convent, who, from his limited means, supplied the funds by which a considerable portion of this ancient structure has been exposed to view. The ancient tradition is, that this church was founded by Constantine on the site of the house of St. Clement, the fellow-labourer of St. Paul. That there was one there in the fifth century there can be no donbt, but it was more than once destroyed and rebuilt, and the new church now stands above the level of the columns of the original edifice. A remarkable confirmation of the tradition as to the time of the erection of the subterranean building has been found in an inscription, on a slab discovered in one of the aisles, which gives the names of the consuls of the year 339. Before I close this reference to the progress of Archæological researches in "the Eternal City," I must mention that the first volume of the great work by De Rossi on the Christian Inscriptions found at Rome has been published. The whole collection numbers about 11,000, of which 4,000, drawn from the catacombs, are anterior to the time of Constantine, and about 1,250 bear dates.

The labours of the Prussian Commission in Athens have been rewarded by discoveries of singular interest. Prof. Strack had the honor of pointing out the spot where the remains of the Theatre of Dionysius were found, and early in the year the thirteen lowest rows of seats, with two marble thrones in front, were exposed to view. Other important results are expected from the excavations carried on under the superintendence of two other members of this Commission, Profs. Böttiger and Curtius. The enquiries of the former were directed to the Erectheion and Parthenon, of the latter to the Pnyx.

In France, the researches promoted by the Emperor have been rewarded by the discovery and identification of some localities mentioned by Cæsar in his account of his Gallic wars. The question relative to the points from which Julius Cæsar started, and at which he landed, in his invasion of Britain, has been reconsidered. The first of these has been fixed at Wissant, coorrectly, as seems to me; but others believe either Boulogne or Calais, especially the former, to have stronger claims to identification with the *Portus Itius*. The other point, *scil*, that of his landing, has been placed at Deal, or between Walmer Castle and Sandwich; but on this we may expect more definite information when the report of an English committee appointed to investigate the subject shall have been published.

The excavations, which are proceeding in England, near Wroxeter, the ancient Viroconium, may be expected to yield a considerable number of Roman relics—already some valuable remains have been discovered. The ambitious name, however, which has been given to the place, "the British Pompeii," is likely to raise hopes which will certainly not be realized. Very lately in the north of England, in the line of the Roman Wall, at Benwell, the ancient *Condercum*, two altars have been discovered, the inscriptions on which add another name to the list of the deities worshipped by the northern nations in the Roman period.

The Runic inscriptions which were discovered about two years ago at Maeshowe in the Orkneys have been deciphered and translated by Profs. Stevens, Munch and Rafn with but partial success. I perceive by a recent announcement that much light has been thrown on them, and a more satisfactory explanation offered by Dr. Barclay, Principal of the University of Glasgow.

In Africa some very important discoveries have been made. Many interesting relics, including a large number of inscriptions, amongst them one in Libyan characters, have been lately exhnmed in Algiers; and other explorations at Carthage have yielded some most valuable remains, especially specimens of Phœnician Epigraphy.

In Industry and Art the great event of the year has been the International Exhibition; and nobly has this glorious project for national improvement by national competition been a second time carried out. The building, however open to objection as a specimen of architectural taste and skill, seems to have admirably answered the purposes for which it was intended, and the Exhibition itself must be regarded as completely successful. An examination of the awards of the judges presents results well worthy of consideration; my limits, however, permit me only to take a passing glance at them. In machines of all classes, tools, philosophical instruments, naval architecture, cars and carriages, glass and lace, Great Britain stands foremost—in ceramic works and those in metal, in dyes and chemicals, in sculpture, and, strange to say, in food substances, France bears the palm, whilst she disputes precedence in woollen fabrics with Austria and England, in furniture with Italy and Spain, and bears favourable comparison in painting with the Belgians, the Dutch, the Zollverein, and the Scandinavians. Our continent has not been as well represented at this exhibition as at that of 1851. Our friends in the United States have been so engrossed with the deplorable war, which has taxed all their energies to supply materials for its prosecution, that their contributions have been wholly disproportionate to their vast means, whilst we ourselves have done little more than manifest the unrivalled resources of Canada in woods and in minerals. In this display we have again had the advantage of Sir W. Logan's assistance, and the Province can point with pride to the Catalogue of her Economic Minerals by one of her most gifted sons as the model of what such a work should be. Nor should I omit noticing the valuable aid rendered by Dr. Hurlburt in the department of forest products.

Magnificent as was the scene presented at the *concursus* of nations in this temple of Industry and Art, there was that which dimmed its brightness—from the full enjoyment there was a drawback, in the absence of him,

> "The silent father of our kings to be,
> Mourn'd in that golden hour of jubilee,"

to whom was due the honor of having first conceived and carried out the glorious idea of collecting in one spot the natural and artificial productions of the nations of the earth, as the means of mutual improvement, as an index of the progress of human civilization, and as a standard of the advancement of Industry and Art. In the inscrutable wisdom of the Almighty, the Prince Consort was removed before he saw the second triumph of the noble project which he had originated, but though absent, he was present in the memory of the hundreds of thousands of visitors, who deplored the loss of one who had right royally discharged his duty towards his adopted country, and whose name will long be held in fond remembrance throughout every part of the British dominions, as "Albert the Good." And now having taken a hasty and imperfect glance at the principal points of interest in the progress of Science, Industry, and Art, during the past year, permit me briefly to enquire what we have been doing ourselves—what has been the work of the Institute during 1862. On reference to our *Journal*—for in estimating the work of our members, I consider only the communications which have been published—I find that in the six numbers for the past year, there are nineteen original papers, exclusive of Reviews and Scientific and Literary notes. Although such a result of a year's work may be regarded by some as much less than what ought to be expected, when the large number of members of the Institute is taken into account, I cannot but think that reflection will prove that this view of it should not be entertained. In the first place, the character of the articles suitable for publication in a *Journal*, which has already attained distinction amongst Scientific and Literary periodicals, is such that there must necessarily be but few capable of writing them. The chief object of our *Journal* is the advancement of human knowledge by the publication of original matter, comprehending new facts, or hypotheses, or deductions, corrections of errors, and such communications as define or extend the limits of what is known. Now in communities much older and more numerous, and more favourably circumstanced than ours, there are comparatively but few who have the necessary qualifications for handling such subjects. What then may be expected of a young Province—not yet a century old—in which the great majority are occupied in acquiring or securing the means of subsistence or comfort—in which there are necessarily but few that are so highly educated as to have reached the point of knowing what has been accomplished in each department and what remains to be done—and in which, of those few that have the requisite qualifications, the greater number, in consequence of the requirements of their official or social position, can find but little time for the prosecution of those subjects of study to which they would desire to devote their leisure? Let me add to this the want of libraries, museums, and instruments, such as would be necessary to place investigators here in an equal position with labourers in the same fields of research in an European capital. Such considerations as these must induce us rather to feel satisfied than discontented with what we have done during the past year. And yet I doubt not that more might have been done—I doubt not that more will be done; for I am persuaded that some of our members, well qualified to give effective aid, are deterred from even making the attempt by apprehensions which I cannot but regard as ill founded. Some of those, with whom I have spoken on the subject, seemed to think that discoveries were hopeless under the circumstances in which we are placed, except, indeed, in those investigations which have for their object the peculiarities of the region which we inhabit. The broad Atlantic, say they, interposes between them and the objects of their study—all that can be done by them is to form probable conjectures, which sight might materially modify. And yet the history of some of the greatest discoveries in our time shews the fallacy of this reasoning. LeVerrier and Adams, by the force of mathematical reasoning, had discovered the existence and calculated the position of Neptune before mortal eye had ever looked upon its orb; the investigations of Bessel and Peters had found out the companion of Sirius before it was visible through any telescope; Sir Roger Murchison announced the existence of auriferous strata in Australia before the labour of the miner was rewarded by a single grain of gold; Bunsen predicted the presence of a new alkaline metal before a particle of *Cæsium* or *Rubidium* had ever been exposed to view; Grotefend made the first step towards the reading of the cuneiform language, with the aid merely of engraved representations of some inscriptions, before he had ever seen a tablet or a cylinder. Why, then, may not similar results be attained here by those who adopt similar means? I see around me those who have cultivated the subjects of their special study up to that point at which valuable results of original researches may naturally be expected; whilst there are very few indeed of our members who are not qualified by their reading to add to the pleasure of our weekly meetings by the communication of papers of general interest, not suitable, it may be, for the pages of our *Journal,* but yet imparting information in a new or attractive form, welcome for their intrinsic merit, welcome also as the earnest of better things to come. Let us, then, gentlemen, proceed in the course which we have so far successfully pursued, thankful for the past, hopeful for the future, with the determination to contribute, so far as in us lies, towards the advancement of knowledge and the attainment of truth, and with the desire to extend the usefulness of an Institute, destined, I doubt not, to do good service in promoting "Industry, Science, and Art," in fostering intellectual and literary pursuits amongst our population, and in elevating the reputation of our country.

A POPULAR EXPOSITION OF THE MINERALS AND GEOLOGY OF CANADA.

BY E. J. CHAPMAN, Ph. D.
PROFESSOR OF MINERALOGY AND GEOLOGY IN UNIVERSITY COLLEGE, TORONTO.

PART V.

CANADIAN ROCK-FORMATIONS: THEIR SUBDIVISIONS, FOSSILS, ECONOMIC MATERIALS, AND TOPOGRAPHICAL DISTRIBUTION.

Introductory Notice.—The lowest rocks of the geological series, hitherto recognised, consist of a vast thickness of crystalline and semi-crystalline strata, or beds in a more or less altered or metamorphic condition, entirely destitute of organic remains, and hence classed together under the common term of *Azoic Rocks.* They are regarded as sedimentary deposits, collected in the earlier seas which extended over the greater portion of the earth during that period of its history which preceded the creation of organic types In Canada, as will be seen below, these Azoic rocks are enormously developed.

Above the deposits of the Azoic Age, various sandstones, limestones, slates and other strata, in which organic remains first appear, are recognized as forming the second geological series, and are known collectively as *Palæozoic Rocks.* The term "Palæozoic," signifying "ancient life," is bestowed on these strata in allusion to the marked difference which prevails between their organic types, viewed as a whole, and those belonging to existing Nature. Among the more remarkable extinct forms of the Palæozoic Age, Graptolites, Cystideans, numerous Brachiopods, Orthoceratites, Trilobites, and some peculiar fishes, hold a prominent place. Reptilian types are rare, and of comparatively low organization; and Mammalia appear to have been entirely absent. In Canada, the lower members of the Palæozoic strata are largely developed, but the higher divisions of the series are of only partial occurrence, or are altogether wanting.

The strata of a succeeding series, still ascending in the geological scale, are known as *Mesozoic* or *Secondary Fossiliferous Rocks.* Their organic remains are quite distinct from those which occur in the underlying formations. Ammonites and Belemnites, with highly organized reptilian types, including the Ichthyosaurus, Plesiosaurus, Pterodactyl, Iguanodon, &c., are among their more characteristic and extinct forms. Fishes with equally-lobed tail-fins, and others with scale-coverings similar to those of the great majority of fishes which inhabit our present waters, first appear in the deposits of this Secondary Fossiliferous Age. Mammalian types are all but unknown, and those hitherto discovered, are of low organization. In Canada, the Mesozoic rocks are without representatives.

The *Cainozoic* or *Tertiary Fossiliferous Strata* succeed the Mesozoic. In these, the organic remains closely approximate to the forms of the present epoch. Amongst the mollusca, brachiopods become scarce, and cephalopods with chambered shells have greatly diminished. Those with foliated septa (as ammonites, baculites, &c.) have entirely disappeared, together with the huge and abnormal reptiles of the Mesozoic Age. Mammalian types, on the other hand, are fully represented—examples of all existing orders, with the exception of that in which Man is alone included, being met with in these deposits. In Canada, however, the Cainozoic formations do not occur.

Finally, a still higher series of deposits, partly merging into the Cainozoic, where these occur, and in part consisting of the products of existing causes, may be classed together under the term of Post-

Tertiary deposits. These, which include the great Drift formation, and sundry accumulations of more recent origin, are largely developed in Canada.

SKETCH-SECTION OF CANADIAN ROCK-FORMATIONS.

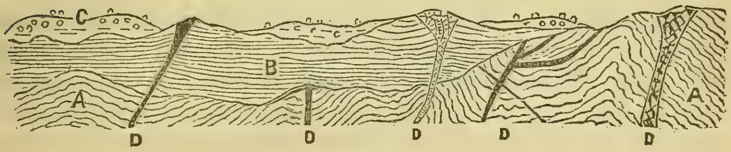

Fig. 151.

A=Azoic Strata (Laurentian and Huronian.)
B=Palæozoic Strata (Chiefly Silurian and Devonian.)
C=Post-Tertiary deposits (Drift and Modern accumulations.)
D=Eruptive rocks (Traps, Trachytes, Syenite, Granite.)

Our rock-formations, therefore, as shown in the accompanying diagram, comprise representatives of the Azoic, Palæozoic, and Post-Tertiary series, a wide break occurring between the two latter,—together with trap dykes and other masses of eruptive origin. The subdivisions and leading characters of these will now be considered. We commence with the older formations, and proceed upwards to those of modern date.*

AZOIC ROCKS OF CANADA.

Huronian.
Laurentian.

The Canadian rock-formations of Azoic age, are referred to two series: the *Laurentian*, below; and the *Huronian* above. This subdivision, not yet fully recognized by American geologists, was first proposed by Sir William Logan; and the terms "Laurentian" and "Huronian" are of his bestowal. The former is now adopted in Europe for gneissoid strata of the same ancient date. The Laurentian series, which forms the lower and more largely developed portion of the Azoic group, is chiefly characterised by its highly crystalline condition, and (as regards Canada) by the great beds of iron ore which it contains. The Huronian series includes many conglomerates and partially-metamorphosed slates amongst its strata, and is traversed by numerous quartz veins holding copper pyrites and other copper ores. Iron ore is also associated with this series, but not abundantly in Canada. The semi-crystalline condition of its rocks (as compared with the highly crystalline gneissoid strata of the Laurentian series) and the marked prevalence of slaty conglomerates, constitute its more distinctive characters.

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* In the present place, these rock-formations will be considered separately, and in a more or less detailed manner as regards structural characters, economics, characteristic fossils (when exhibited), localities of instructive exposures, and other allied points of inquiry; and afterwards, in a connected sketch, their mutual relations will be shewn, together with the special geological areas which occur within the Province. The general reader will scarcely gain a clear idea of the Geology of Canada, until after the perusal of this latter section. The present details are necessary, however, as an introduction to this.

Laurentian Series.—These strata, the oldest series of deposits recognised on the American continent, are regarded as sedimentary accumulations, originally collected together by the action of water, and converted subsequently into a crystalline condition by the agency of metamorphic forces. (See under the head of "Metamorphic Rocks" in *Part III*). Their absolute thickness cannot be ascertained, but it must be very great, embracing many thousands of feet; and their exposed area in Canada, as estimated by Sir William Logan, covers a surface of about 200,000 square miles. It will be convenient to consider these Laurentian rocks under the following heads:—(1) Mineral characters; (2) Structure; (3) Associated intrusive rocks; (4) Economic materials; and (5) Topographical distribution.

Mineral characters of the Laurentian strata;—The stratified rocks of Laurentian age consist essentially of vast beds of micaceous and hornblendic gneiss; interstratified with subordinate beds of quartz-rock' mica-slate, hornblende-rock, crystalline limestone and dolomite, and oxidized iron ores; and associated with thick beds of feldspar rock or anorthosite. In addition to these, a few quartzose conglomerates (shewing the metamorphic character of these deposits), thin layers of serpentine, beds and layers of a talcose character (Renselaerite or pyrallolite: see PART II.), and others composed in large part of Wollastonite, are interstratified with the limestones, or with the gneissoid beds, of particular localities. These different kinds of metamorphic rocks have been described already in PART III.; but a few additional remarks on some of their more special characters are necessary here. Viewing our Canadian formations, of this age, in their broader features, we may subdivide them conveniently, and to some extent naturally, into three groups, viz :—(*a*) Gneissoid strata ; (*b*) Limestones, Quartzites, and Iron bands ; and (*c*), Anorthosites or feldspar rocks.

(*a*) *Gneissoid Strata :*—These make up the larger mass of our Laurentian rocks. Ordinary gneiss, as explained in PART III., consists of quartz, potash-feldspar, and mica ; whilst in syenitic gneiss, the mica is replaced by hornblende. These varieties occur both alone and mixed with one another, throughout our Laurentian districts. The feldspar is generally red or white, the quartz colourless and vitreous, and the mica and hornblende of some dark tint—black, brown, or green. The two latter minerals occasionally die out, when a binary mixture of quartz and feldspar results. In certain beds of coarse structure, the stratification lines become obscure ; but usually, and even in hand specimens, gneiss exhibits a striped or banded aspect, by which it is distinguished from ordinary granite. The potash-feldspar or orthoclase (see PART II.) is sometimes replaced or accompanied by soda-feldspar or albite, but the instances of this are not common. The predominating colour of these gneissoid strata, is reddish or dark grey, the latter resulting from stripes of dark mica combined with narrow zones of white quartz and white or pale red feldspar. When much hornblende is present, the rock may assume a black or dark greenish colour, or present a flecked surface of red and black : exhibiting in the former case, a transition into hornblende-rock. A red gneiss with green layers of epidote, forming a stone well adapted for ornamental purposes, occurs at Carlton Place near Kingston, and at some other localities. The black or dark-green hornblende-rock associated with the gneissoid and limestone strata, frequently contains crystals of red garnet (Barrie township, &c.) ; and the latter mineral sometimes occurs in the gneiss or quartzites in considerable abundance (Grenville, River Rouge, &c.) It is usually found, however, in the vicinity of the limestone bands, occasionally forming true garnet-rock.

(*b*) *Limestones, Quartzites, and Iron Ores :*—The limestone beds associated with the gneissoid and other Laurentian rocks are often of a fine granular or saccharoidal texture ; at other times coarse granular, and occasionally almost compact. The colour is usually white or grey, but for short distances the rock is sometimes of a pale reddish, or greenish tint. It is frequently zoned with specks and scales of mica, serpentine, or graphite, and contains also various accidental minerals, of which the more abundant or interesting comprise : Iron pyrites ; apatite or phosphate of lime ; sulphate of baryta ; tremolite, diopside, and other varieties of hornblende and augite; garnet; tourmaline; condrodite; spinel; corundum, molybdenite, &c. Descriptions of these minerals are given in PART II. of this series of Papers. A talcose mineral (Renselaerite or Pyrallolite), probably an altered augite, (see PART II.) occurs also in interstratified beds with the limestones of some localities (Ramsay, Grenville, Rawdon); and in Grenville and Burgess, yellowish and greenish-grey serpentine occurs under similar conditions. Phosphate of lime likewise, occasionally forms irregular bands amongst the strata: as, more especially, in North Elmsley, South Burgess, and Ross; and at Calumet Falls.

Some of the limestone beds are of great thickness. According to Sir William Logan, who has devoted much time to an elaborate examination of the crystalline limestones of the Ottawa region in particular, certain beds exhibit a thickness of 1500 feet. In the district alluded to, four beds, presenting an aggregate thickness of over 3500 feet, have been traced out and mapped. For full information respecting the structural and other characters of these, the reader is referred to the Revised Report on the Geology of Canada, by Sir William Logan and the other officers of our Geological Survey.* The more important localities in which workable beds of crystalline limestone occur, will be found under the head of "Economic Materials," below. The crystalline dolomites, composed of carbonate of lime and carbonate of magnesia, closely resemble the crystalline limestones, and occur under the same conditions, the two being frequently interstratified. A fine saccharoidal variety is found on Lake Mazinaw in the County of Frontenac, and a more compact kind occurs in the townships of Madoc, McNab, Loughborough, Sheffield, Grenville, &c. Many of these dolomites, it is remarked by Sir William Logan, become of a yellowish brown colour by weathering.

The quartzites and quartzose conglomerates, mentioned above, may be referred to in connection with the limestones, as they are generally found in their immediate vicinity or otherwise interstratified with them. Some beds of quartzite present a thickness of several hundred feet. This rock, composed of quartz more or less pure, exhibits a vitreous or sub-vitreous aspect, and is either colourless or of a pale reddish, brownish, or greenish tint. The quartzose conglomerates are comparatively rare, but some occur in the townships of Rawdon and Bastard, associated with crystalline limestone. They are usually somewhat micaceous, and the imbedded pebbles consist of quartz, feldspar, (often decomposed), sandstone, and sometimes of limestone. The quartzites of Bay St. Paul, and those of Rawdon, contain garnets in great abundance, and pass into garnet rock.

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* To this valuable and truly national work, it may be mentioned here, the present Essay is mainly intended to serve as an introduction: illustrating and explaining the various technicalities and details, a knowledge of which, on the part of the reader, is necessarily presupposed in the Report in question.

The beds of iron ore, also placed in this subdivision from their general association with the crystalline limestones and dolomites, belong partly and chiefly to Magnetic iron oxide, and partly to Specular iron ore—minerals of which full descriptions are given in PART II. of this Essay. These ores occur in vast beds interstratified with the limestones and other Laurentian strata. In thickness they vary from a yard or two, to upwards of two hundred feet. Their more important localities are mentioned below.

(*c*) *Anorthosites* :—The term anorthosite was first employed by Prof. Sterry Hunt of the Geological survey, to designate the more purely feldspathic rocks of the Laurentian series. These rocks consist of a mixture of lime and soda feldspars—minerals forming several species (Labradorite, Albite, Anorthite, &c., see PART II), all of which belong to the Triclinic or Anorthic system of crystallization (PART I.) The anorthosites make up in themselves a vast thickness of the Laurentian rocks, and cover surface areas of large extent. They appear, according to Prof. Hunt, to occupy a higher position than the orthoclase gneiss-rocks, although occasionally interstratified with subordinate beds of these, and also, though more rarely, with strata of quartz-rock. Their structure is coarsely crystalline, or otherwise more or less compact; and their marks of stratification are frequently obscure. They often contain laminar masses of hypersthene of a brown (or green) submetallic tint; and when this mineral becomes somewhat abundant, the variety termed "hypersthene rock" originates (see PART III.) Ilmenite or titaniferous iron ore (described in PART II) is also sometimes present. An immense bed, 300 feet long and about 90 feet wide, occurs in a feldspathic rock of this series, near Bay St. Paul, below Quebec. These rocks are chiefly of a greyish blue colour, but some are white, and others exhibit a yellowish, greenish, or reddish tint. All become opaque white by weathering. Many contain cleavable masses of lime feldspar or Labradorite (PART II.), or appear to be almost wholly made up of that mineral. In these, a fine green and blue opalescence or play of colour is sometimes observable: as in the anorthosite of the township of Abercrombie in the county of Terrebonne, in those of Morin and Mille-Isles, and in some of the boulders met with in the Ottawa district.

2. *Structure of Laurentian rocks:*—These rocks, as a general rule, occur in inclined beds—the dip varying from eight or ten to over seventy degrees. The direction of the dip is extremely variable, as the strata are not only inclined, but are folded more or less into a series of anticlinals and synclinals. In some beds, both of gneiss and limestone, the subordinate layers are much contorted, as shown in the annexed figure, sketched on Crow Lake, north of Marmora; and the same peculiarity is seen in many other localities. Between the Laurentian strata and the Silurian beds which rest upon them in Eastern and the greater part of Western Canada (the Huronian being absent), there is always a want of conformability. Along the line of junction of the two formations, between the eastern extremity of Lake Ontario and the east coast of Georgian Bay, the Laurentian strata appear to dip very generally towards the north, that is, between N.W. and N.E., or away from the Silurian beds—as shown in the accompanying section, taken on Lake St. John in the township of Rama, C. W. The dotted line in this section shows the ordinary level of the lake. The Laurentian strata have a general northerly dip also, near the junction line of the two formations in the township of Elzevir, and at other points visited by the writer; but this does not apply everywhere, as on Loughborough and Crow Lakes the dip is SE. or nearly so; neither does it continue apparently for any great distance to the north, the dip rapidly changing with the foldings of the strata. The Sketch-section on a previous page (fig. 151), in which an attempt is made to convey an idea of the foldings of the Laurentian strata generally, will render this sufficiently clear.

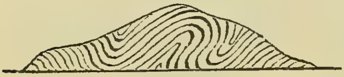

Fig. 152.

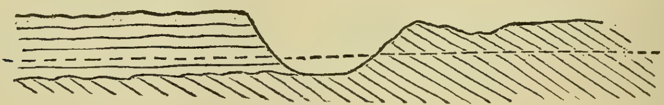

Fig 153.

3. *Intrusive Rocks:*—Considering the immense extent of country occupied by the Laurentian rocks, intrusive masses of contempora-

neous geological age, appear to be exceedingly rare. Many of the granitoid and quartzose veins seen amongst the gneissoid strata, are considered, by those who have had the best opportunities to study them, as veins of segregation rather than true eruptive matters. The most important example of undoubted eruptive origin, is the great mass of syenite described by Sir William Logan as occupying an area of about thirty-six square miles in the townships of Grenville, Chatham, and Wentworth, near the left bank of the Ottawa. This consists of red or white potash-feldspar, with black hornblende, and a small amount of quartz; but here and there it contains a certain amount of mica also, forming the variety generally known as syenitic granite. This eruptive mass cuts a series of greenstone dykes belonging to a still earlier eruption; and is in itself traversed by another series of porphyritic dykes of a necessarily more recent origin. The greenstone dykes, according to Sir William Logan, exhibit a well-marked columnar structure, and vary in width from a few feet to a hundred yards. These three eruptive formations are also intersected by a fourth series of dykes, supposed to be of Palæozoic age. (See Report for 1853. Also the Revised Report on the Geology of Canada). As the more northern and uncleared districts within the vast area of our Laurentian region become opened up or more thoroughly explored, other eruptive masses of an analogous character will, in all probability, be brought to light.

4. *Economic Materials:*—In addition to good building stones of gneiss, &c., obtainable generally throughout the region occupied by our Laurentian rocks, the following are the more important economic materials discovered in these strata up to the present time:* (*a*) *Iron Ores;* (*b*) *Lead Ore;* (*c*) *Sulphide of Molybdenum;* (*d*) *Graphite;* (*e*) *Mica;* (*f*) *Ornamental Feldspars;* (*g*) *Marbles;* (*h*) *Sulphate of Baryta:* (*i*) *Millstones.*

(*a*) *Iron Ores.*—These comprise Magnetic Oxide of Iron; Specular Iron ore (or Red oxide of Iron); and Titaniferous Iron Ore. The magnetic ore occurs principally at the following localities:—(1) Belmont Township (the Marmora mine): several beds, lying between crystalline limestone and gneiss, and mixed with layers of serpentine, talcose slate, &c. Total thickness of the ore beds, over 400 feet.—2, Madoc Township: Bed of ore of excellent quality, 25 feet thick, in gneiss.—3, South Crosby Township, Newborough mine: Bed in gneiss, on Mud Lake, 200 feet in thickness.—4, South Sherbrooke Township: Bed of 12 feet in gneiss.—5, Hull Township on the Ottawa: Dome-shaped bed in gneiss; thickness, about 90 feet.—6, Grenville Township, C. E.: Bed of 10 or 12 feet in thickness.—7, Grandison Township, C. E., 20 feet bed. The average amount of iron in these beds, varies from 60 to 70 per cent. Specular iron ore (averaging about 55 per cent. of metal) occurs in a 30 feet bed, in the township of McNabb, near the Lac des Chats. Also in "Iron Island" on Lake Nipissing. Titaniferous Iron (Ilmenite), as already mentioned, forms a bed of 90 feet in thickness, in Feldspar-rock (anorthosite) at Bay St. Paul on the Lower St. Lawrence.

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* These various substances will be found described in full, as regards mineral characters, composition, &c, in PART II. of this Essay.

(*b*). *Lead Ore*:—This consists of galena or sulphide of lead. Mixed with a gangue of calc spar and heavy spar it forms a series of narrow veins in the townships of Lansdowne, Ramsay, and Bedford, C. W. These veins, which vary in thickness from six inches to a foot, belong, probably, to a somewhat more recent period of formation than the Laurentian epoch; but as they occur among the Laurentian rocks, they are properly mentioned in connexion with these strata. The lead ore is very slightly argentiferous, and apparently in no great quantity in the veins. It occurs also, under similar conditions, in the township of Dummer, Peterborough Co., C. W.

(*c*). *Sulphide of Molybdenum*:—This mineral (see PART II.) is not at present of much value. It forms the source of various molybdenum compounds, some of which are employed in chemical investigations, and occasionally in porcelain painting. It occurs, in small quantities, in the Laurentian rocks of several localities, as mentioned under the description of the mineral in a preceding part of this Essay; but in workable quantities it has only been found, as yet, at the mouth of the Quetachoo River on the north shore of the Gulf of St. Lawrence. ("Descriptive Catalogue of the Economic Minerals of Canada in the Exhibition of 1862"—issued by the Geological Survey.)

(*d*). *Graphite*:—Found in workable quantities in the Augmentation of Grenville, on the Ottawa, (see PART II.) Also in the townships of Burgess and Lochaber. The quality is scarcely sufficient to render the substance available as a material for pencils, but the graphite of these localities is well adapted for refractory crucibles, and also as a burnishing material for stoves and grates.

(*e*). *Mica*:—This mineral occurs in pieces sufficiently large for stove-doors, &c., in the townships of North and South Burgess, C. W. Also in Grenville and the "Augmentation" of that township in C. E.

(*f*). *Ornamental Feldspars* :—These comprise, the Labradorite of Abercrombie township, C. E.; the Peristerite (an iridescent variety of Albite) found in the townships of Bathurst and Burleigh, C. W.; and the Perthite (an iridescent Orthoclase,) of the township of Burgess. See PART II. The two latter varieties were first made known (as occurring in these localities) by Dr. James Wilson of Perth.

(*g*). *Marbles* :—The principal marbles of Laurentian age occur at the following localities: Arnprior, MacNabb township (grey, striped); Grenville township (white with yellowish specks of serpentine, or yellowish-white); Augmentation of Grenville (white with pale green spots of serpentine); Elzevir township, C. W., (white but of somewhat coarse grain); Barrie township, at Lake Mazinaw, &c., (a crystalline dolomite, pure white, and of saccharoidal texture).

(*h*). *Sulphate of Baryta* :—This substance, used as a paint material or substitute for white lead (see PART II.), is found in considerable quantities, in connexion with Laurentian rocks, in the townships of Lansdowne, Burgess, Bathurst, and Dummer, in Canada West, where it occurs in the form of veins which often contain galena. It is found still more abundantly on Lake Superior, but in rocks of another age.

(*i*). *Millstones* :—The intrusive mass of syenite in the township of Grenville, C. E., (described under the head of "Eruptive Rocks" above) is associated with some remarkable veins of *chert* (a variety of quartz) from which good millstones have been manufactured. These veins are regarded by Sir William Logan as veins of segregation; and it is considered probable that the siliceous matter of which they consist may have been derived from the decomposition of the feldspar in the adjoining mass of syenite. The feldspar is said to be converted into kaolin for a considerable distance on each side of the chert.

5. *Area of the Laurentian Rocks* :—As shewn by the shaded surface in the accompanying map, (figure 154), the Laurentian strata may be regarded as constituting from the coast of Labrador, the whole of the north shore of the Saint Lawrence to within a short distance of Quebec (Cape Tourmente)—a few isolated and narrow strips of Lower Silurian strata (made known by the Geological Survey) alone intervening between these rocks and the waters of the Gulf or river. These outlying patches occur on the north shore of the Straits of

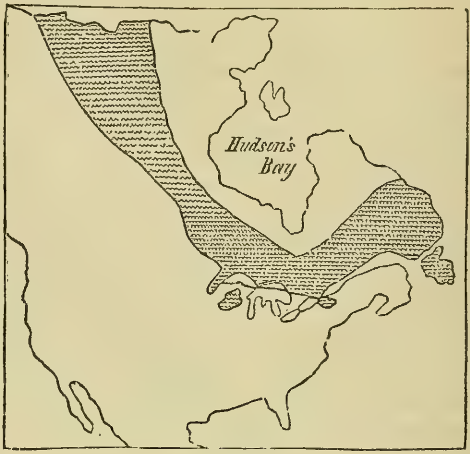

Fig. 154.

Belle Isle, at the mouth of the Mingan River, near the Seven Islands, and at the Murray Bay River, and the Gouffre. From Cape Tourmente, the Laurentian strata run inland, at a distance of from ten to thirty miles from the river but roughly parallel with its course, and cross the Ottawa near the Lac des Chats. From this point, the strata extend both southwards and to the northwest. The southern portion crosses the Saint Lawrence about the Thousand Isles, and occupies a large area in the State of New York between Lake Ontario and Lake Champlain, including the wild district of the Adirondack Mountains. The narrow belt of crystalline rock connecting this southern Laurentian area with the main or northern region of these strata, probably exerted at the close of the Drift period, as discussed on a succeeding page, a remarkable influence on the physical condition of the country to the west. The other portion of the Laurentian outcrop, west of the Lac des Chats, traverses the back townships of the counties of Frontenac, Addington, Hastings, Peterborough, Victoria, and Simcoe, and strikes Georgian Bay near the mouth of the River Severn. From thence, the Laurentian rocks form the eastern and north-eastern shores of the Bay up to a point nearly opposite the east end of the Manitoulin Islands, or some five or six miles west of the most western mouth of French River, where they are overlaid by Huronian deposits. They reappear upon the east and north shore of Lake Superior, and extend far into the great North-West—reaching in all probability to the shores of the Arctic Ocean. The vast area thus occupied by the Laurentian rocks, includes many thousands of square miles; and that part of it which lies within the limits of Canada properly so-called, greatly exceeds in extent the other portions of the Province.

6. *Agricultural Capabilities :*—As a general rule, liable only to par-

tial or local exceptions, the Laurentian area is not favorably circumstanced for agricultural occupation. Soils of depth and fertility can only be expected to occur under the following conditions :—first, where feldspar rocks or anorthosites prevail, most of these yielding calcareous soils by decomposition ; secondly, where the belts of crystalline limestone crop out and form the surface of the country ; and thirdly, where the rocks are covered to a sufficient depth by Drift clays and sands. These latter deposits, however, are usually filled in these districts with large and numerous boulders, and rarely extend over areas of any considerable size. Patches of a certain extent occur here and there, but they are too generally separated by huge and bare masses of gneissoid rock, familiarly known to the settlers as "elephants backs." Such, at least, is the general condition of the country in the back townships of the western counties mentioned above. Northwards, and in Eastern Canada, the severe climatic relations which there prevail, must be added to these disadvantages. In those parts of the province, however, which are occupied by other rock-formations, numerous uncleared tracts of unrivalled fertility are still left to repay the settler's toil.

Huronian Series :—The rocks of this group, the next in ascending order above the Laurentian series of strata, may be described under the following heads :—1, Mineral characters ; 2, Associated intrusive rocks ; 3, Economic materials ; and 4, Topographical distribution.*

1. *Mineral Characters of the Huronian Strata* :—These rocks consist principally of thick beds of quartzite, passing into quartzose and jasper conglomerates ; green slate rocks passing into slate conglomerates ; bands of compact or sub-crystalline limestone ; and interstratified masses or beds of greenstone. The entire thickness of the series, where fully displayed, is probably not far short of 20,000 feet. The quartzites are chiefly white or greenish in colour, but exhibit in some places grey, brownish, and also red tints. Some are vitreous in texture ; others, more or less arenaceous. In the conglomerates, the included pebbles, which are sometimes quite small, consist of different varieties of quartz—colourless, opaque-white, brown, black, dark-red,

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* It is but just to state, that most of the facts given under these heads, are drawn from the publications of the Geological Survey of Canada. The writer, however, has visited the north shore of Lake Huron where the rocks of this series are chiefly displayed ; and he has thus examined many of the strata and greenstone masses *in situ*, and has procured, personally, a considerable collection of specimens from that locality. He is consequently better able than a mere compiler would be, to classify and separate from subordinate details the more salient points belonging to the study of this geological group. These observations will apply also to other cases in which he is more especially indebted to the labours of the Survey

&c.,—the latter constituting the variety known as jasper. The slates and slate conglomerates appear to owe their general green colour to the presence of chlorite and epidote, or perhaps more commonly to the former alone. In some, different shades of green (or of green, black, and red) run in parallel lines, imparting to the rock a beautiful riband-ed aspect. Well-marked slaty cleavage, however, is apparently very rare : if ever present. In the conglomerates, the enclosed pebbles, or rounded fragments, for some are eight or ten inches across, consist of pieces of gneiss, syenite, quartz, &c., evidently derived in many instances from the adjacent Laurentian rocks. Some of these slates and slate conglomerates form vast stratified masses of between two and three thousand feet in thickness. The limestone beds of the Huronian series are of comparatively subordinate importance. They are chiefly of a light or dark grey colour, though in places they offer a white, greenish or brownish tint. In structure, they are more or less compact, or but slightly crystalline ; the latter condition is, however, rare. Some exhibit a brecciated appearance, and all seem to contain a good deal of siliceous matter. Thin beds of chert (a flinty variety of quartz) occur indeed interstratified with them, in some places. In addition to their want of crystalline texture, these limestones differ from those of the Laurentian series in not containing any crystallized minerals—apatite, garnets, tourmaline, homblende, &c.,—a fact pointed out by Professor Sterry Hunt. The masses of greenstone interstratified with the slates and other beds of this series, are of somewhat doubtful origin. They may consist, as suggested by Prof. Hunt, of altered sedimentary deposits ; or they may be stratified beds made up of materials derived from neighbouring dykes and eruptive greenstone masses ; or, otherwise, they may consist of overflows of igneous rock during the building up of the associated strata ; or of lateral dykes, so to say, forced at some after period between the lines of bedding. As regards structure, &c., they exhibit several varieties. Some are large-grained, consisting of feldspar (usually of a greenish-white color) and dark green or black hornblende. Other varieties are fine-grained, and of a uniform green colour except when they become amygdaloidal or contain cavities filled with calc spar, magnesite, quartz, &c. Certain fine-grained varieties also become schistose and quite sectile, from the presence of a large quantity of chlorite. These finer greenstones are likewise porphyritic in places, or hold imperfect crystals of feldspar ; and those of coarser grain, by the addition of a little quartz, pass occasionally into syenitic gneiss or syenite—according as to whether the rock be regarded as of sedimentary or eruptive origin.

2. *Associated Intrusive Rocks, Mineral Veins, &c* :—The intrusive rocks which break through the Huronian series, and belong apparently to the same geological period, consist of numerous dykes of dark greenstone, varying in breadth from less than a foot to two hundred feet or more; and of some large masses and veins of red granite, frequently of an epidotic character. An exposure of the latter occurs in force on the north shore of Lake Huron, associated with Laurentian strata, but is regarded by Sir William Logan as most probably of Huronian age from its agreement in mineral characters with similar veins which traverse the deposits of that period at neighbouring localities. Some of the greenstone dykes are older, and others newer, than the granite masses. The vein-fissures filled with copper pyrites, &c., which are so abundant amongst these Huronian strata, are of still later formation, since they cut many of the greenstones and granites, and often break the continuity of these and the surrounding beds, causing upthrows or downthrows of greater or less extent. An enormous fault caused by a dislocation of this character, has been traced out by Mr. Murray in the valley of the Thessalon and adjoining district. In one place, a downthrow of nine thousand feet is attributed to this fault. (See the Report for 1858. Also *Canadian Journal*, vol. V, p. 463.) Finally, it may be observed that several large anticlinals extend across the Huronian strata of this region generally. The axis or summit of one of these, crosses the workings of the Bruce Mines.

3. *Economic Materials* :—The more important substances of this class obtained from the Huronian rocks, comprise: copper ores; quartzose sandstones suitable for glass making purposes; hones of good quality; and (as ornamental stones) the jasper conglomerates mentioned above. The copper ores belong chiefly to copper pyrites, purple copper pyrites or erubescite (the "horse flesh ore" of the miners), and copper glance: minerals which have been fully described in PART II. These occur on the north shore of Lake Huron in veins or lodes, varying in thickness from about two to ten feet. The gangue or veinstone consists essentially of quartz, and the average yield of metal is said to be from six to eight per cent: amounting, however, in the dressed ore to about eighteen or twenty per cent. The principal workings are at the Bruce Mines (Cuthbertson location), Wellington Mines (Keating location), and at the Copper Bay Mines; but ore has

been found also at the Wallace Mine near the mouth of White Fish River, at Echo Lake, Root River, Garden River, Mississagui River, Spanish River, and other localities of that region. The ore (according to Mr. Murray's observations) appears to be far more abundant in the greenstones than in the quartzites. Lodes of some richness in the greenstone, when passing into the latter frequently become quite poor. Ottertail Lake, an expansion of the Thessalon River, is named by the Geological Survey as a locality from which good hones may be obtained. They are cut from the green or greyish siliceous slates, found towards the base of the series. From some of the soft chloritic slates, also, the Indians have long obtained sufficiently compact and sectile masses to be worked into pipe-bowls and other objects.

4. *Topographical Distribution* :—The Huronian rocks are unknown throughout the greater portion of Western Canada, and in the East they appear to be entirely wanting. The Laurentian rocks of these districts, either form the surface of the ground, with or without a covering of Drift, or are otherwise overlaid unconformably by Silurian strata—the Huronian being absent. The principal Huronian area extends along the north coast of Lake Huron from a few miles west of French River, where this enters the lake, up to the the neighbourhood of Root River opposite the northern part of Sugar Island, or to within a short distance of the Sault Ste. Marie. A narrow strip of the shore-line, however, from about ten miles north of the entranc to Lake George to a point west of Little Lake George, consists apparently of newer strata. The extension northward of this Huronian belt has not yet been definitely made out, but it does not appear to exceed ten or fifteen miles, and in places is less than this. Huronian rocks are exposed also at several points on Lake Superior: as in Batchehwahnung Bay; at the mouth of the Doré, and around the lower part of Michipicoten River; in strips along the coast farther west; and more extensively around the lower part of the Kaministiquia River, and elsewhere, on the coast of Thunder Bay. In many parts of this region, the Huronian rocks are followed unconformably by a somewhat similar series of altered strata, associated with dykes and interstratified masses of trap, and containing also, copper ores, native copper, and other metallic matters. Until recently, these strata were considered to be of Huronian age; but they are now looked upon as altered Silurian deposits, belonging in part to the Potsdam group,

and partly to the Calciferous or Quebec Series. They will be described, consequently, under those divisions.

[The present series of papers on the Minerals and Geology of Canada will be concluded in two other articles. These will comprise a review of our Silurian and higher strata, with many figures of characteristic fossils, sections, &c., and a brief recapitulatory sketch of the geology of the Province generally.]

ILLUSTRATIONS OF THE SIGNIFICANCE OF CERTAIN ANCIENT BRITISH SKULL FORMS.

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During a recent visit to Washington, I availed myself of the facilities afforded me by Professor Henry, the learned Secretary of the Smithsonian Institution, to examine with minute care the ethnological collections preserved there, including those formed by the United States Exploring Expedition; and especially a highly interesting collection of human crania. The latter includes those of Esquimaux and Tchuktchi, a number of compressed and greatly distorted Chinook and other Flathead skulls, as well as examples of those of other Indian tribes, both of North and South America; and of Fiji, Kanaka, and other Pacific islanders. On my return I spent a short time in Philadelphia chiefly for the purpose of renewed study of the valuable materials of the Mortonian collection; and while there enjoyed the opportunity of examining, in company with Dr. J. Aitken Meigs, a series of 125 Esquimaux crania obtained by Dr. Hayes during his Arctic Journey of 1854.

The materials for craniological investigation which such collections supply can scarcely be surpassed in some of their departments; and invite to very diverse researches by the illustrations they are calculated to afford. It chanced, however, that my attention had been recently recalled to an old subject of speculation, relative to the possible modification of the forms of ancient British crania by some of the very causes which so materially alter those of many American tribes; and this accordingly influenced me in part, in the notes I made of the collections both at Washington and Philadelphia; and will now give direction to some remarks bearing on the same inquiry.

Among the most prized crania in the collection of the Academy of Natural Sciences at Philadelphia is the celebrated Scioto Mound skull. But though on a former visit, I made the ancient mound crania an object of special study, this most remarkable example of the series was not then included among them; and I now examined the original for the first time. The result of this examination was to satisfy me that the remarkable form and proportions of that skull are much more due to artificial influences than I had been led to suppose from the views published in the *Smithsonian Contributions to Knowledge*.* The vertical view, especially, is very inaccurate. In the original it presents the peculiar characteristics of what I have before designated as the truncated form: passing abruptly from a broad flattened occiput to its extreme parietal breadth, and then tapering with slight lateral swell, until it reaches its least breadth immediately behind the external angular processes of the frontal bone. The occiput has been subjected to the flattening process to a much greater extent than is apparent from the drawings; but at the same time it is accompanied by no corresponding affection of the frontal bone, such as inevitably results from the procedure of the Chinooks and other Flathead tribes; among whom the desired cranial deformation is effected by bandages crossing the forehead and consequently modifying the frontal as much as the parietal and occipital bones. On this account, great as is the amount of flattening in this remarkable skull, it is probably due solely to the undesigned pressure of the cradle-board acting on a head of markedly brachycephalic proportions and great natural posterior breadth. The forehead is fully arched, the glabella prominent, and the whole character of the frontal bone is essentially different from the Indian type. The sutures are very much ossified; and even to some extent obliterated. So early as 1857, when discussing Dr. Morton's theory of one uniform cranial type pervading the whole ancient and modern tribes of North and South America, with the single exception of the Esquimaux, I remarked: I think it extremely probable that further investigation will tend to the conclusion that the vertical or flattened occiput, instead of being a typical characteristic, pertains entirely to the class of artificial modifications of the natural cranium familiar to the American ethnologist alike in the disclosures of ancient graves, and in the customs of widely separated living tribes.†

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* *Ancient Monuments of the Mississippi Valley: pl.* xlvii. and xlviii.

† *Edinburgh Philosoph. Journal*, *N. S.*, vol. vii. p. 24. *Canadian Journal*, vol. ii. p. 406.

This idea received further confirmation from noticing the almost invariable accompaniment of such traces of artificial modification, with more or less inequality in the two sides of the head. In the extremely transformed skulls of the Flathead Indians, and of the Natchez, Peruvians, and other ancient nations by whom the same barbarous practice was encouraged, the extent of this deformity is frequently such as to excite surprise that it could have proved compatible with the healthful exercise of any vital functions. But the aspect in which it is now purposed to review the subject of artificial modifications of the human cranium, in relation to ancient British skull-forms, was suggested, in the same paper above referred to, when pointing out the mistaken idea adopted by Dr. Morton, that such unsymmetrical conformation, or irregularity of form, is peculiar to American crania.* The latter remark, I then observed, is too wide a generalization. I have repeatedly noted the like unsymmetrical characteristics in the brachycephalic crania of Scottish barrows; and it has occurred to my mind, on more than one occasion, whether such may not furnish an indication of some partial compression, dependent, it may be, on the mode of nurture in infancy, having tended, in their case also, if not to produce, to exaggerate the short longitudinal diameter, which constitutes one of their most remarkable characteristics.

The idea thus expressed, in a paper read before the American Scientific Association at Montreal, as well as at the Dublin meeting of the British Association in 1857, was the result of observations made before leaving Scotland in 1853. One section of the *Prehistoric Annals of Scotland* is devoted to a discussion as to the ethnological significance of the crania of Scottish Tumuli; and after its publication I availed myself of every favourable opportunity for adding to the rare materials illustrative of that interesting department. In pursuing such researches my attention was repeatedly drawn to the unsymmetrical proportions of ancient brachycephalic skulls, and to their peculiar truncated form, accompanied, as in the mound skull of the Scioto Valley, by an abrupt flattening of the occiput which I soon began to suspect was due to artificial causes. Since then the facilities derived from repeated examinations of American collections have familiarized me, not only with the extreme varieties of form of which the human head is susceptible under the influence of artificial compression; but also with the less marked changes undesignedly resulting from such seemingly slight causes as the constant pressure of the Indian cradle-board. The examination and measurement of several hundred specimens of American crania, as well as of the living head in representatives of various Indian tribes, have also satisfied me not only of the existence of dolichocephalic and brachycephalic heads as tribal or national characteristics, but of the common occurrence of the same exaggerated brachycephalic form, accompanied with the vertical or obliquely flattened occiput, which had seemed to be characteristic of the crania of the Scottish tumuli. There are indeed ethnical differences apparent, as in the frontal and malar bones, but so far as the posterior region of the head is concerned, both appear to exhibit the same undesigned deformation resulting from the process of nursing still practised among many Indian tribes.

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* *Crania Americana*, p. 115. *Types of Mankind*, p. 444.

The light thus thrown on the habits of the British mother of prehistoric times, by the skull-forms found in ancient barrows, is replete with interest, from the suggestions it furnishes of ancient customs hitherto undreamt of. But it has also another and higher value to the craniologist, from its thus showing that some, at least, of the peculiar forms hitherto accepted as ethnical distinctions, may be more correctly traced to causes operating after birth.

The first example of this peculiar cranial conformation which attracted my attention, as possibly traceable to other causes than inherited characteristics, or natural deviations from the typical skull-form of an extinct race, occurred on the opening of a stone cist at Juniper Green, near Edinburgh, on the 17th of May, 1851. Soon after the publication of the *Prehistoric Annals of Scotland,* in which the special characteristics of the crania of the Scottish tumuli were first discussed, I learned of the accidental discovery of an ancient tomb in a garden on the Lanark road, a few miles to the north-west of Edinburgh, and immediately proceeded to the spot. The cist occupied a slightly elevated site, distant only a few yards from the road; and as this had long been under cultivation as a garden, if any mound originally marked the spot it had disappeared, and no external indication distinguished it as a place of sepulture. A shallow cist formed of unhewn slabs of sandstone enclosed a space measuring three feet eleven inches in length, by two feet one inch in breadth at the head, and one foot eleven inches at foot. The joints fitted to each other with sufficient regularity to admit of their being closed by a few stone chips inserted at the junction, after which they appeared to have been carefully cemented with wet loam or clay. The slab which covered the whole projected over the sides, so as effectually to protect the sepulchral chamber from any infiltration of earth. It lay in a sandy soil, within little more than two feet of the surface; but it had probably been covered until a comparatively recent period by a greater depth of earth, as its site was higher than the surrounding surface, and possibly thus marked the traces of the nearly levelled tumulus. Slight as this elevation was it had proved sufficient to prevent the lodgment of water, and hence the cist was found perfectly free from damp. Within this a male skeleton lay on its left side. The arms appeared to have been folded over the breast, and the knees drawn up so as to touch the elbows. The head had been supported by a flat water-worn stone for its pillow; but from this it had fallen to the bottom of the cist, on its being detached by the decomposition of the fleshly ligatures; and, as is common in crania discovered under similar circumstances, it had completely decayed at the part in contact with the ground. A portion of the left side is thus wanting; but with this exception the skull was not only nearly perfect when found, but the bones are solid and heavy; and the whole skeleton appeared to me so well preserved as to have admitted of articulation. Above the right shoulder, a neat earthen vase had been placed, probably with food or drink. It contained only a little sand and black dust when recovered, uninjured, from the spot where it had been deposited by affectionate hands many centuries before, and is now preserved along with the skull in the Scottish Museum of Antiquities.

As the peculiar forms of certain skulls, such as one described by Dr. Thurnam, from an Anglo-Saxon cemetery at Stone, in Buckinghamshire, * and another from an Indian cemetery at Montreal in Lower Canada, † as well as those of numerous distorted crania, from the Roman site of Uriconium and other ancient cemeteries, have been ascribed to posthumous compression: the precise circumstances attendant on the discovery of the Juniper Green cist are important, from the proof they afford that the body originally deposited within it, had lain there undisturbed and entirely unaffected by any superincumbent pressure from the day of its interment. Two, if not three, classes of skulls have been recovered from early British graves. One with a predominant longitudinal diameter, in the most marked examples differs so essentially in its elongated and narrow forehead, and occiput from the modern dolichocephalic head, that I was led to assign it to

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* *Crania Britannica*, Dec. I. p. 38.

† Edin. Philosoph. Journal, N. S. XVI. p. 269.

a separate class under the title kumbecephalic.* Another has the longitudinal diameter little in excess of the greatest parietal breadth, and is no less strikingly distinguished from the prevailing modern head, whether of Celtic or Saxon areas, by its shortness, than the other is by its length, when viewed either in profile or vertically. The Anglo-Saxon type of skull appears to be intermediate between those two forms, with a more symmetrical oval, such as is of common occurrence in modern English skulls.

If cranial conformation has any ethnical significance, it appears to me inconceivable that the two extreme forms above referred to can both pertain to the same race; and the circumstances under which the most characteristic examples of the opposite types have been found, confirm me in the belief which I advocated when the evidence was much less conclusive, that the older dolichocephalic or kumbecephalic skull illustrates the physical characteristics of a race which preceded the advent of the Celtæ in Britain, and gradually disappeared before their aggressions. As, however, the opposite opinion is maintained by so high an authority as Dr. J. Barnard Davis, the comparison of the following measurements, illustrative of the three types of head, will best exhibit the amount of deviation in opposite directions from the intermediate form. The measurements are taken from those furnished in the *Crania Britannica*, and include the *longitudinal diameter, frontal, parietal, and occipital breadth, parietal height, and horizontal circumference.* No. 1, like the majority of the same class, is derived from a megalithic chambered barrow, and has been selected by Dr. Davis as a characteristic example of the class to which it belongs;† though, according to him, that is one of aberrant deviation from the typical British form. No. 2, obtained from a barrow at Codford, in Wiltshire, has also been selected by Dr. Davis as one of three typical British crania. It is of the same type as the Juniper Green skull, and its strongly marked characteristics are thus defined by him: "Its most interesting peculiarities are its small size, and its decidedly brachychepalic conformation. This latter character, which commonly appertains to the ancient British cranium, and even to that form which we regard as typical, is seldom met with expressed in so marked a manner."‡ No. 3, is a skull from an Anglo-Saxon cemetery near Litlington, Sussex, one of two of which Dr. Davis remarks: "There is a general indication of good-form in these fine capacious skulls, which is apparent in every aspect. . . On a review of the whole series of Anglo-Saxon crania which have come under our notice, we are led to conclude that this pleasing oval, rather dolichocephalic form, may best be deserving the epithet of typical among them."* All the three examples are male skulls:

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* *Prehistoric Annals of Scotland*, p. 177.

† Proceedings of the *Acad. Nat. Sciences*, Philadelphia, 1857, p. 42.

‡ *Crania Britanica*, Dec. ii., pl. 14.

	L. D.	F. B	P. B.	O. B.	P. H.	H. C.
1. Uley Chambered Barrow Skull	8.1	4.7	5.7	5.	5.1	21.7
2. Codford Skull....................	6.8	4.6	5.7	5.1	4.7	20.
3. Litlington Skull.................	7.5	4.7	5.3	4.6	4.9	20.9

Each of the above examples presents the features of the type to which it belongs with more than usual prominence, so that if the mean of a large series were taken, the elements of difference between the three would be less strongly defined. The differences are, however, those on which their separate classification depends; and they thus illustrate the special points on which any craniological comparison for ethnological purposes must be based. Of the three skulls, the era and race of one of them (No. 3) are well determined. It is that of a Saxon, probably of the seventh or eighth century, of the race of the South Saxons, descended from Ælla and his followers; and recovered in a district where the permanency of the same ethnic type is illustrated by its predominance among the rural population at the present day. Another of the selected examples, No. 2, is assumed by Dr. Davis, perhaps on satisfactory grounds, to be an ancient British, *i.e.*, Celtic Skull. It is indeed a difficulty, which has still to be satisfactorily explained, how it is that if this brachycephalic type be the true British head-form, no such prevalence of it on modern Celtic areas is to be found, as in the case of Saxon Sussex connects the race of its ancient pagan and christian cemeteries, by means of the characteristic ovoid skull, with the Anglo-Saxon population of the present day. The historical race and era with which Dr. Davis appears to connect the Barrow-builders of Wiltshire, is thus indicated in the *Crania Britannica*:—"Region of the Belgæ, Temp. Ptolemæi, A.D. 120." The Belgæ of that era—then apparently comparatively recent intruders, and by some regarded as not Celtic but Germanic—were displaced, if not exterminated; but the modern Britons of Wales are undoubted descendants of British Celts of Ptolemy's age. Though doubtless mingling Saxon and Norman with pure British blood, they probably preserve the native type as little modified by such foreign admixture as that of its supplanters in the most thoroughly Saxon or Anglish districts of England. It is therefore a question of some importance how far the extreme brachycephalic proportions of the so-called British type may be traceable to other than inherited ethnical characteristics; whether in fact it is not entirely due to the undesigned flattening of the occiput, and lateral expansion of the brain and skull, consequent on the use of the cradle-board.

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* *Crania Britanica*, Dec. iv., pls. 39, 40.

Meanwhile, turning from this supposed British skull of Roman times, to the one derived from Uley chambered barrow, No. 1, the most ancient of the series, and assuming their chronological order to be undisputed, as it appears to be: we find no gradation from an abbreviated to an elongated form, but, on the contrary, an extreme brachycephalic type interposed between the ovoid dolichocephalic Anglo-Saxon of the Christian era, and the extreme dolichocephalic, or kumbecephalic one belonging to a period seemingly so remote that Dr. Thurnam, when noting the recurrence of the same type in another chambered barrow at Littleton Drew, Wiltshire, remarked: "It is not necessary to admit the existence of any pre-Celtic race, as the skulls described may be those of Gaelic, as distinguished from Cymric, Celts; or the long-headed builders of these long, chambered, stone barrows, may have been an intrusive people, who entered Britain from the South-west. Can they have been some ancient Iberian or Ibero-Phœnician settlers?"*

Among the rarer crania of the Morton collection is one to which a peculiar interest attaches, and which may possibly have some significance in reference to this inquiry. Its history is thus narrated in Dr. Henry S. Paterson's Memoir of Dr. Morton: During a visit of Mr. Gliddon to Paris, in 1846, he presented a copy of the *Crania Ægyptiaca* to the celebrated oriental scholar, M. Fresnel, and exited his interest in the labours of its author. Upwards of a year after he received at Philadelphia, a box containing a skull, forwarded from Naples, but without any information relative to it. "It was handed over to Morton," says Dr. Paterson, "who at once perceived its dissimilarity to any in his possession. It was evidently very old, the animal matter having almost entirely disappeared. Day after day would Morton be found absorbed in its contemplation. At last he announced his conclusion. He had never seen a Phœnician skull, and he had no idea where this one came from; but it was what he conceived a Phœnician skull should be, and it could be no other."* Six months afterwards Mr. Gliddon received, along with other letters and papers forwarded to him from Naples, a slip of paper, in the handwriting of M. Fresnel, containing the history of the skull, which had been discovered by him during his exploration of an ancient tomb at Malta. Dr. Meigs refers to this in his catalogue of the collection, (No. 1352,) as an illustration of "the wonderful power of discrimination, the *tactus visus*, acquired by Dr. Morton in his long and critical study of craniology." Such was my own impression on first reading it; but I confess the longer I reflect on it, the more am I puzzled to guess by what classical or other data, or process short of absolute intuition, the ideal type of the Phœnician head could be determined. I suspect, therefore, if we had the statement in Dr. Morton's own words, it would fall short of such an absolute craniological induction. The following is the sole entry made by him in his catalogue: "Ancient Phœnician? I received this highly interesting relic from M. F. Fresnel, the distinguished French archæologist and traveller, with the following memorandum, A. D. 1847:—Crâne provenant des caves sépulchrales de Ben-Djemma, dans l'ile de Malte. Ce crâne parait avoir appartenu à un individu de la race qui, dans les temps les plus anciens, occupait la côté septentrionale de l' Afrique, et les iles adjacentes." The sepulchral caves of Ben-Djemma, are a series of galleries with lateral chambers or catacombs hewn in the face of the cliffs on the southwest side of the island of Malta. Other traces besides the rock-hewn tombs indicate the existence of an ancient town there, although no record of its name or history survives. M. Frédérick Lacroix remarks, in his *Malte et le Goze*, "Whoever the inhabitants of this city may have been, it is manifest from what remains of their works, that they were not strangers to the processes of art. The sepulchral caves, amounting to a hundred in number, receive light by means of little apertures, some of which are decorated like a finished doorway. In others, time and the action of the humid atmosphere, have obliterated all traces of such ornament, and left only the weathered rock. . . The chambers set apart for sepulture are excavated at a considerable distance from the entrance, in the inmost recesses of the subterranean galleries. The tombs are of admirable design and style of art, and the details of their execution exhibit remarkable ingenuity and purity of taste. The author of the *Voyage pittoresque de Sicile* does not hesitate to declare that they surpass in elegance any that he has seen executed on the same scale. What hand has hewn out these gloomy recesses in the rock? To that we can give no reply. The chronicles of Malta are silent on this point. Time has defaced the vestiges which might otherwise have helped to the solution of the problem."*

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* *Crania Britannica,* Dec. iii. pl. 24, (4.)

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* *Memoir of S. G. Morton; Types of Mankind*, p. xl.

Other and very remarkable remains of antiquity abound in Malta and the neighbouring island of Goza, including the cyclopean ruins styled *La tour des Géants*, which have also been assigned by some writers to a Phœnician or Punic origin, as a temple dedicated to Astarte; and the *Tadarnadur Isrira*, a magalithic structure for which a Pelasgic origin is assumed. But in drawing any comparison between the chambered galleries of Ben-Djemma and the megalithic chambered barrows or cairns of the British Islands, we are at best reasoning from the little known to the less known indices of prehistoric races; between whom the points in common may amount to no more than those which admit of a comparison being drawn between the Brachycephali of the British Stone-Period, and the corresponding physical form and rude arts of American gravemounds.

Nevertheless the Ben-Djemma skull in the Mortonian collection is not improbably what it has been assumed it to be; and it is in many respects a remarkable one. A deep indentation at the nasal suture gives the idea of an overhanging forehead, but the superciliary ridges are not prominent, and the peculiar character of the frontal bone is most strikingly apparent in the vertical view, where it is seen to retreat on either side, almost in a straight line from the centre of the glabella to the external angular processes of the frontal bone. The contour of the coronal region is described by Dr. Meigs as "a long oval, which recalls to mind the kumbecephalic form of Wilson."† It it is of more importance, perhaps, to note that the remarkable skull recovered by Dr. Schmerling, from the Engis Cavern, on the left bank of the Meuse, buried five feet in a breccia, along with the tooth of a rhinoceros and other fossil bones, appears to be of the same elongated dolichocephalic type. Its frontal development is long and narrow;

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* *Malte et le Goze*, p. 21.

† Catalogue of Human Crania in the Academy of Nat. Sciences of Philadelphia, p. 29.

and its greatest relative proportions, in length and breadth, are 7·7 by 5·25 inches, so that it closely corresponds in those respects to the most characteristic British kumbecephalic crania.*

Whatever be the final conclusion of ethnologists, as to the evidence which led me to adopt that name to indicate the characteristics of a preceltic British race; the necessity appears to be acknowledged for some such term to distinguish this form from the ordinary dolichocephalic type. The Ben-Djemma skull is narrow throughout, with its greatest breadth a little behind the coronal suture, from whence it narrows gradually towards front and rear. The lower jaw is large and massive, but with less of the prognathous development than in the superior maxillary. The skull is, no doubt, that of a man, and the nose has been prominent; but the zygomatic arches are delicate, and the whole face is long, narrow, and tapering towards the chin. The parietals meet at an angle, with a bulging of the sagittal suture, and a slight but distinctly defined pyramidal form running into the frontal bone. The occiput is full, round, and projecting a little more on the left side than the right. The measurements are as follows:—

Longitudinal diameter	7.4	
Parietal diameter	5.1	
Frontal diameter	4.	
Vertical diameter	5.3	
Intermeatoid arch	12.3	
Intermastoid arch	15.	(?)
Intermastoid line	4.3	(?)
Occipito-frontal arch	14.2	
Horizontal circumference	20.2	

I have been thus particular in describing this interesting skull, because it furnishes some points of comparison with British kumbecephalic crania, bearing on the inquiry, whether we may not thus recover traces of the Phœnician explorers of the Cassiterides in the long-headed builders of the chambered barrows. When contrasting the wide and nearly virgin area with which Dr. Morton had to deal, with that embraced in the scheme of the *Crania Britannica,* I remarked in 1857:—Compared with such a wide field of investigation, the little island home of the Saxons may well seem narrow ground for exploration. But to the ethnologist it is not so. There, amid the rudest traces of primeval arts, he seeks, and probably not in vain, for the remains of primitive European allophyliæ. There it is not improbable that both Phœnicians and early Greek navigators have left behind them evidences of their presence, such as he alone can discriminate.*

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* *Natural History Review,* vol. i.

Before, however, we can abandon ourselves to the temptations of so seductive a theory,—which, after all, finds only such support as may be deduced from a certain general analogy of cranial form; and derives no confirmation from the works of art accompanying the remains of the long-headed barrow builders;—it has to be borne in remembrance that the question is still disputed with reference to this class of British dolichocephalic crania: are they examples of an essentially distinct type, preserving evidence of the characteristics of a different race, or are they mere exceptional aberrant deviations from the supposed brachycephalic Celtic, or British type? Much stress is laid on the fact that the two forms of skull have occasionally been recovered from the same barrow; from which it may be inferred that the two races to which I conceive them to have belonged, were for a more or less limited period contemporaneous. More than this I cannot regard as a legitimate induction from such premises, in relation to crania of such extremely diverse types. But this amounts to little; for the same is undoubtedly true of the ancient British and the modern Anglo Saxon race; and the discovery of Celtic and Saxon skulls in a common barrow or tumulus of the 6th century is no proof that the latter race was not preceded by many centuries in the occupation of the country, by the Britons, among whom they then mingled as conquerors and supplanters.

But the elongated skulls of the Uley barrow type are no rare and exceptional forms. They have been most frequently found in tombs of a peculiar character, and of great antiquity. Many have been recovered in too imperfect a state to admit of more being deduced from the fragments than that these conform to the more perfect examples of this peculiar form. Nevertheless the number already obtained in a sufficiently perfect state to admit of detailed measurement is remarkable, when their great age, and the circumstances of their recovery are fully considered. Of this the following enumeration will afford satisfactory proof. Only two perfect crania from the chambered tumulus of Uley, in Gloucestershire,—of which the proportions of one are cited above,—have been preserved. But in the later search of Mr. Freeman, and Dr. Thurnam, in 1854, the fragments of eight or nine other skulls were recovered, and of these the latter remarks: "The fragments are interesting, as proving that the characters observed in the more perfect crania were common to the individuals interred in this tumulus. Three or four calvaria are sufficiently complete to show that in them likewise the length of the skulls had been great in proportion to the breadth."* Again in the megalithic tumulus of Littleton Drew, North Wilts, at least twenty-six skeletons appear to have been found, from several of which imperfect crania were recovered, and of those Dr. Thurnam remarks: "Eight or nine crania were sufficiently perfect for comparison. With one exception, in which a lengthened oval form is not marked, they are of the dolichocephalic class."† So also the four nearly perfect skulls from West Kennet are described as "more or less of the lengthened oval form, with the occiput expanded and projecting, and presenting a strong contrast to skulls from the circular barrows of Wilts and Dorset."‡ To these may be added those of Stoney Littleton, Somersetshire, first pointed out by Sir R. C. Hoare; || and examples from barrows in Derby, Stafford, and Yorkshire, described by Mr. Thomas Bateman in his "Ten Years' Diggings in Celtic and Saxon Grave Hills;" including those from Bolehill, Longlow, and Ringham Low, Derbyshire; from the galleries of the tumulus on Five Wells Hill; and from the Yorkshire barrow near Heslerton-on-the-Wolds. Several of the above contained a number of skulls; and of the last, in which fifteen human skeletons lay heaped together, Mr. Bateman remarks: "The crania that have been preserved are all more or less mutilated; but about six remain sufficiently entire to indicate the prevailing conformation to be of the long or kumbecephalic type of Dr. Wilson."§ The crania occuring in graves of this class mentioned by Mr. Bateman alone, exceed fifty in number, of which the majority are either of the elongated type, or too imperfect to be determined. The others include between thirty and forty well-determined examples, besides a greater number in too imperfect a state to supply more than indications of their correspondence to the same characteristic form. Alongside of some of these are also found brachycephalic crania; but in the most ancient barrows the elongated skull appears to be the predominant, and in some cases the sole type; and of the examples found in Scotland, several

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* *Canadian Journal*, vol. ii. p. 445.

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* *Archæol. Journal,* vol. xi. p. 313. *Crania Britannica,* Dec. I. pl. 5, (5).

† *Crania Britannica,* Dec. III. pl. 24, (3).

‡ *Ibid,* Dec. V. pl. 50 (4.)

|| *Archæologia,* vol. xix. p. 47.

§ *Ten Years' Diggings in Celtic and Saxon Grave Hills.* p. 230.

have been recovered from peat bogs, or others under circumstances more definitely marking their great antiquity.

The variations of cranial form are thus, it appears, no gradual transition, or partial modification, but an abrupt change from an extreme dolichocephalic to an extreme brachycephalic type; which, on the intrusion of the new and essentially distinct Anglo-Saxon race, gives place once more to a dolichocephalic form of medium proportions. The three forms may be represented, reduced to an abstract ideal of their essential diversities by means of the following diagram:*—

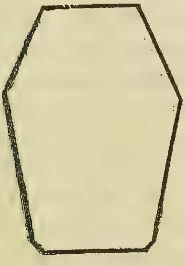

Fig. 1.

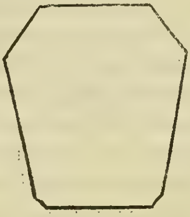

Fig. 2.

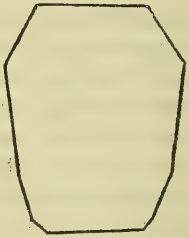

Fig. 3.

Leaving, meanwhile, the consideration of the question of distinct races indicated by such evidence, it will be well to determine first if such variations of skull-form can be traced to other than a transmitted ethnical source. The Juniper Green skull, already referred to, presents in profile, as shown in the full sized view in the *Crania Britannica*, the square and compact proportions characteristic of British brachycephalic crania. It also exhibits in the vertical outline, the truncated wedge form of the type indicated in Fig. 2. In the most strongly marked examples of this form, the vertical or flattened occiput is a prominent feature, accompanied generally with great parietal breadth, from which it abrubtly narrows at the occiput. The proportions of this class of crania were already familiar to me before the discovery of the Juniper Green example; but it had not before occurred to me to ascribe any of their features to other than natural causes. But the circumstances attending its exhumation gave peculiar interest to whatever was characteristic in the skull and its accompanying relics, handled for the first time as evidences of the race and age of the freshly opened cist, discovered almost within sight of the Scottish Capital, and yet pertaining to prehistoric times. The skull was carried home in my hand a distance of several miles, and its truncated outline, and still more, its flattened occiput attracted special attention, and gave rise to conversation with my friend Mr. Robert Chambers, who had accompanied me on this exploratory excursion. With the temptation of a novel discovery, I was at first disposed to recognise the traces of art in this abbreviated form, not only as exaggerating the natural characteristics, but as a possible source of their production. But a comparison with examples of the true dolichocephalic skull, to which I had already assigned priority in point of time, sufficed to dispel that illusion, and to satisfy me—of what the examination of the corresponding classes of Peruvian crania has still more strongly confirmed,—that no artificial modification can entirely efface the distinctions between two such diverse forms. At a subsequent meeting of the Society of Antiquaries of Scotland, I accompanied the presentation of the cranium and urn with an account of the circumstances of their discovery, and some remarks on the novel features noticeable in the skull. Unfortunately the printing of the Society's Proceedings, which had been suspended for some time, was not resumed till the following season; and no record of this communication was preserved beyond the title.

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* Owing to inaccurate copying on the part of the wood engraver, the diagrams, especially fig. 3, do not correspond on opposite sides, as they ought to do.

Another skull in the same collection, found under somewhat similar circumstances in a cist at Lesmurdie, Banffshire, has the vertical occiput accompanied by an unusual parietal expansion and want of height, suggestive of the idea of a combined coronal and occipital compression.* A third Scottish skull, procured from one of a group of cists near Kinaldie, Aberdeenshire, also exhibits the posterior vertical flattening. But a more striking example than any of those appears in the one from Codford, South Wiltshire, selected above to illustrate this type.† Dr. Davis remarks in his description of it:—"The zygomatic arches are short, a character which appertains to the entire calvarium, but is most concentrated in the parietals, to which the abruptly ascending portion of the occipital lends its influence. The widest part of the calvarium is about an inch behind, and as much above the auditory foramen, and when we view it in front we perceive it gradually to expand from the outer angular process of the frontal to the point now indicated." The entire parieto-occipital region presents in profile an abrupt vertical line; but when viewed vertically it tapers considerably more towards the occiput than is usual in crania of the same class.

The cause of the vertical occiput, as well as the oblique parieto-occipital flattening in this class of British Crania, I feel no hesitation in believing to be traceable to the same kind of rigid cradle-board as is in constant use among many of the Indian tribes of America, and which produces precisely similar results. Its mode of operation, in effecting the various forms of oblique and vertical occiputs, will be considered, when describing some of the phenomena of compressed Indian crania; but another feature of the Juniper Green skull, which is even more obvious in that from Lesmurdie, in the same collection, is an irregularity amounting to a marked inequality in the developement of the two sides. This occurs in skulls which have been altered by posthumous compression; but the recovery of both the examples referred to from stone cists, precludes the idea of their having been affected by the latter cause; and since I was first led to suspect the modification of the occiput, and the exaggeration of the characteristic proportions of British brachycephalic crania by artificial means, familiarity with those of the Flathead Indians, as well as other ancient and modern artificially distorted American crania, has led me to recognise in them the constant occurrence of the same unsymmetrical inequality in opposite sides of the head.

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* *Crania Britannica*, Dec. ii. pl. 16.

† *Ibid*, Dec. ii. pl. 14.

But another class of deformations, of a less marked character than the well-known distortions produced on many American crania, both by the undesigned action of the cradle-board, and by protracted compression purposely applied with a view to change the form, merits the careful attention of craniologists. The normal human head may be assumed to present a perfect correspondence in its two hemispheres; but very slight investigation will suffice to convince the observer that few living examples satisfy the requirements of such a theoretical standard. Not only is inequality in the two sides frequent, but a perfectly symmetrical head is the exception rather than the rule. The plastic condition of the cranial bones in infancy, which admits of all the strange malformations of ancient Macrocephali and modern Flatheads, also renders the infant head liable to many undesigned changes. From minute personal examination I have satisfied myself of the repeated occurrence of inequality in the two sides of the head, arising from the mother being able to suckle her child only at one breast, so that the head was subjected to a slight but constantly renewed pressure in the same direction. It is surprising, indeed, to how great an extent such unsymmetrical irregularity is found to prevail, when once the attention has been drawn to it. The only example of the Greek head possessed by Dr. Morton, was a cast presented to him by Dr. Retzius, and which, from its selection by the distinguished Swedish craniologist for such a purpose, might reasonably be assumed to illustrate the Greek type. It is accordingly described by Dr. J. Aitken Meigs, in his "Cranial characteristics of the Race of Man," as very much resembling that of Constantine Demetriades, a Greek native of Corfu, and long a teacher of the modern Greek language at Oxford, as engraved in Dr. Prichard's *Researches*. Its cranial characteristics are thus defined in the Catalogue of the Mortonian Collection: (No. 1354,) "The calvarial region is well developed, the frontal line expansive and prominent, the facial line departs but slightly from the perpendicular." On recently visiting Philadelphia for the purpose of renewed examination of its valuable collections, I was surprised to find this head,—instead of being either oval or as Blumenback describes the example selected by him, sub-globular,—presenting the truncated form, with extreme breadth at the parietal protuberances, and then abruptly passing to a flattened occiput. It measures 6.5 longitudinal diameter; 5.7 parietal diameter; and 19.2 horizontal circumference. But the most noticeable feature is the great inequality of the two sides, the right side is less tumid than the left, while it projects more to the rear, and the whole is fully as unsymmetrical as many American crania. Were it not that this feature appears to have wholly escaped Dr. Morton's attention, as he merely enters it in his catalogue as a "Cast of the skull of a young Greek, Prof. Retzius;" I should be tempted to suppose it had been purposely sent to him to illustrate the phenomena of unsymmetrical development; and of the influence of undesigned artificial causes on skull-forms.

Dr. Morton was not unobservant of such indications of the frequent dissimilarity between opposite sides of the skull, nor did he entertain any doubt as to its cause when occurring as the accompaniment of other artificial changes, though he entirely overlooked its more general prevalence. When first noticing the probable origin of the flattened occiput of certain British skulls, I drew attention to the fact that he had already recognised undesigned artificial compression as one source of abnormal cranial conformation, and he accompanied its demonstration with a reference to the predominant unsymmetrical form in all such skulls. "This irregularity," he added, "chiefly consists in the greater projection of the occiput to one side than the other," and "is not to be attributed to the intentional application of mechanical force." Such want of uniformity in the two sides of the head is much more strongly marked in the Flathead skulls, which have been subjected to great compression. It is clearly traceable to the difficulty of subjecting the living and growing head to a perfectly uniform and equable pressure, and to the cerebral mass forcing the skull to expand with it in the direction of least resistance. Hence the unsymmetrical form accompanying the vertical occiput in the Lesmurdie and Juniper Green skulls, and, as I conceive also in the Greek skull of Retzius. To me, at least, the study of the latter skull-form has tended strongly to confirm the belief that the extreme abbreviated proportions of many naturally brachycephalic crania are due to artificial causes. Wherever a very noticable inequality exists between the two sides of a skull, it may be ascribed with much probability to the indirect results of designed or accidental compression in infancy; and by its frequent occurrence in any uniform aspect, may, quite as much as the flattened occiput, furnish a clue to customs or modes of nurture among the people to whom it pertains.

Dr. Struthers of Edinburgh has in his collection an interesting example of a modern skull, measuring 7.5 longitudinal diameter, 6.5 parietal diameter, 21.4 horizontal circumference, in which the truncated form is even more strongly marked by the abrupt flattening, immediately behind the parietal protuberances, accompanied with inequality in the two sides of the head. It was obtained from a grave digger in Dundee, who stated it to be that of a middle aged female whom he had known during life. There was nothing particular about her mental developement.

I have also drawn attention in former papers to the fact that such peculiar forms and examples of inequality in the developement of the two sides of the head, are familiar to hat manufacturers. Occasionally the eye is attracted by very unusual cranial forms revealed by baldness; but the hair suffices generally to conceal abnormal irregularities, some of which, as illustrated by hatters' shapes, are extremely odd and fantastical. My attention was originally directed to this familiar test by a remark of the late Dr. Kombst, that he had never been able to obtain an English-made hat that would fit his head. He added that he believed such was the general experience of Germans, owing to the greater length of the English head. I subsequently found the shapes of a Yorkshire hatter to be shorter than some furnished me from Dublin; and I believe that such comparisons of the shapes most in demand in different parts of the British Islands, and on the Continent, will supply important craniological results.

The novel forms thus occurring in modern heads, though chiefly traceable, as I believe, to artificial causes, are not the result of design. But the same is true of the prevalent vertical and obliquely flattened occiput of many ancient and modern American crania, as well as of the British brachycephalic class already described. Nor are such changes of the natural form necessarily limited to skulls of short longitudinal diameter, in which this typical characteristic is exaggerated by the pressure of the cradle-board in infancy. Now that this source of modification begins to receive general recognition among craniologists, its influence is assumed as a probable source of the most diverse aberrant forms. Dr. Thurnam, when referring to two skulls of different shapes, recovered from the same group of British barrows, of "a somewhat late though pre-Roman period," on Roundway Hill, North Wiltshire, thus indicates their contrasting characteristics, and suggests the probable source of such divergence from the supposed British type: "The general form of the cranium (pl. 43.) differs greatly from that from the adjoining barrow, (pl. 42). That approaches an acrocephalic, this a platycephalic form; that is eminently brachycephalic, this more nearly of a dolichocephalic character. As the eye at once detects, the difference is much greater than would be inferred from a mere comparison of the measurements. The respective peculiarities of form in the two skulls, may possibly be explained by supposing that both have been subject to artificial deformation, though of a different kind,—the one appearing to have been flattened on the occiput, the other showing a depression immediately behind the coronal suture, over the parietal bones, which seems to indicate that this part of the skull was subject to some habitual pressure and constriction, perhaps from the use of a bandage or ligature tightly bound across the head and tied under the chin, such as to this day is employed in certain parts of the west of France, producing that form of distortion named by Dr. Gosse, the sincipital, or *tête bilobée*."* The influence of the recognition of this source of change, is indeed very manifest throughout the fifth Decade of the *Crania Britannica*. An extremely brachycephalic skull of a youth, obtained from a barrow on Ballard Down, Isle of Purbeck, is described as unsymmetrical, and as affording "tolerably clear evidence that this form, if not always produced, was at least liable to be exaggerated by an artificial flattening of the occiput, such as is practised by many American and Polynesian tribes."* In the same Decade another skull of the type most dissimilar to this, is described and illustrated. It was recovered in fragments from the remarkable chambered barrow at West Kennet, Wiltshire; and its most characteristic features are thus defined by Dr. Thurnam:—"It is decidedly dolichocephalic, narrow, and very flat at the sides, and realizes more nearly than any we have yet had to figure the kumbecephalic or boatshaped form described by Dr. D. Wilson. The frontal region is narrow, moderately arched and elevated at the vertex, but slopes away on each side. The parietal region is long, and marked by a prominent ridge or *carina* in the line of the sagittal suture, which is far advanced towards obliteration, whilst the other sutures are quite as perfect as usual. The occiput is full and prominent; the supra-occipital ridges only moderately marked. There is a deep digastric groove, and a slight paroccipital process on each side. The external auditory openings are somewhat behind the middle of the skull, and very much behind a vertical line drawn from the junction of the coronal and sagittal sutures." Its extreme length and breadth are 7·7 and 5·1, and an inequality in the development of the two sides is obvious in the vertical view. As the brachycephalic skull recalls certain American and Polynesian forms, so such examples of the opposite type suggest the narrow and elongated skulls of the Australians and Esquimaux: and he thus proceeds:—"The Ballard Down skull bears marks of artificial flattening of the occiput; this calls to mind the artificial lateral flattening of the skull characteristic of the ancient people called Macrocephali, or long-heads, of whom Hippocrates tells us, that 'while the head of the child is still tender, they fashion it with their hands, and constrain it to assume a lengthened shape by applying bandages and other suitable contrivances, whereby the spherical form of the head is destroyed, and it is made to increase in length.' This mode of distortion is called by Dr. Gosse the *temporo-parietal*, or '*tête aplatie sur les côtés*.' It appears to have been practised by various people, both of the ancient and modern world, and in Europe as well as the East. The so-called Moors, or Arabs of North Africa, affected this form of skull; and even in modern times, the women of Belgium and Hamburgh are both described as compressing the heads of their infants into an elongate form. Our own observations lead at least to a presumption that this form of artificial distortion may have been practised by certain primeval British tribes, particularly those who buried their distinguished dead in long chambered tumuli."

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* *Crania Britannica*, Dec. v. pl. 43.

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* *Crania Britannica*, Dec. v. pl. 45.

Accordingly Dr. Thurnam draws attention to the obliteration of the sagittal suture, both in the skull in question, and to a still greater extent in one figured by Blumenbach, under the name of "Asiatic Macrocephali," and expresses his belief that this "has been produced by pressure or manipulations of the sides of the head in infancy, by which it was sought to favour the development of a lengthened form of skull; to which, however, there was probably, in the present instance at least, a natural and inherent tendency." It is perhaps worthy of note here, that a long narrow head has been observed as characteristic of certain Berber tribes, the occupants of ancient Punic sites in North Africa.

It thus appears that a class of variations of the form of the human skull, which becomes more comprehensive as attention is directed to it, is wholly independent of congenital transmitted characteristics. Kumbecephalic, acrocephalic, and platycephalic, unsymmetrical, truncated, or elongated heads, may be so common as apparently to furnish distinctive ethnical forms, and yet, after all, each may be traceable to artificial causes, arising from an adherence to certain customs and usages in the nursery. It is in this direction, I conceive, that the importance of the truths resulting from the recognition of artificial causes affecting the forms of British brachycephalic or other crania chiefly lies. The contents of early British cists and barrows prove that the race with which they originated was a rude people, ignorant for the most part of the very knowledge of metals, or at best in the earliest rudimentary stage of metallurgic arts. They were in fact in as uncivilized a condition as the rudest forest Indians of America. To prove, therefore, that like the Red Indian squaw, the British allophylian or Celtic mother formed the cradle for her babe of a flat board, to which she bound it, for safety and facility of nursing, in the vicissitudes of her nomade life,—though interesting, like every other recovered glimpse of a long-forgotten past,—is not in itself a discovery of much significance. But it reminds us how essentially man, even in the most degraded state of wandering savage life, differs from all other animals. The germs of an artificial life are there. External appliances, and the conditions which we designate as domestication in the lower animals, appear to be inseparable from him. The most untutored nomades subject their offspring to many artificial influences, such as have no analogy among the marvellous instinctive operations of the lower animals. It is not even unworthy of notice that man is the only animal to whom a supine position is natural for repose; and with him more than any other animal, the head when recumbent, invariably assumes a position which throws the greatest pressure on the brain-case, and not on the malar or maxillary bones. Without, therefore, running to the extreme of Dr. Morton, who denied, for the American continent at least, the existence of any true dolichocephalic crania, or indeed any essential variation from one assumed typical form, it becomes an important point for the craniologist to determine, if possible, to what extent certain characteristic diversities may be relied upon as the inherited features of a tribe or race; or whether they are not the mere result of artificial causes originating in long perpetuated national customs and nursery usages. If the latter is indeed the case, then they pertain to the materials of archæological, rather than of ethnological deduction, and can no longer be employed as elements of ethnical classification.

Every scheme of the craniologist for systematising ethnical variations of cranial configuration, and every process of induction pursued by the ethnologist from such data, proceed on the assumption that such varieties in the form of cranium are constant within certain determinate limits, and originate in like natural causes with the features by which we distinguish one nation from another. By like means the comparative anatomist discriminates between the remains of the *Bos primigenius*, the *Bos longifrons*, and other kindred animal remains, frequently found alongside of the human skeleton, in the barrow: and by a similar crucial comparison the craniologist aims at classifying the crania of the ancient Briton, Roman, Saxon, and Scandinavian, apart from any aid derived from the evidence of accompanying works of art. But if it be no longer disputable that the human head is liable to modification from external causes, so that one skull may have been subjected to lateral compression, resulting in the elongation and narrowing of its form; while another under the influence of occipital pressure may exhibit a consequent abbreviation in its length, accompanied by parietal expansion; it becomes indispensable to determine some data whereby to eliminate this perturbing element before we can ascertain the actual significance of national skull-forms. If, for example,—as appears to be the case,—the crania from British graves of Roman times reveal a different form from that of the modern Celtic Briton, the cause may be an intermixture of races, like that which is clearly traceable among the mingled descendants of Celtic and Scandinavian blood in the north of Scotland; but it may also be, in part, or wholly, the mere result of a change of national customs following naturally on conquest, civilization, and the abandonment of paganism for christianity.

It is in this respect, that the artificial causes tending to alter the natural conformation of the human head, invite our special study. They appear at present purely as disturbing elements in the employment of craniological tests of classification. It is far from improbable, however, that when fully understood they may greatly extend our means of classification; so that when we have traced to such causes certain changes in form, in which modern races are known to differ from their ethnical precursors, we shall be able to turn the present element of disturbance to account, as an additional confirmation of truths established by inductive craniology. Certain it is, however, whatever value may attach to the systematising of such artificial forms, that they are of frequent occurrence; apart altogether from such configuration as is clearly referrible to the application of mechanical pressure in infancy with that express object in view; or again, as is no less obviously the result of posthumous compression. But, though the deforming processes designedly practised among ancient and modern savage nations lie beyond the direct purpose of the present inquiry, they are calculated to throw important light on the approximate results of undesigned compression and arrested development.

Among the Flathead Indian tribes of Oregon and the Columbia River, where malformation of the skull is purposely aimed at, the infant's head is tightly bound in a fixed position, and maintained under a continuous pressure for months. But it is a mistake to suppose that in the ordinary use of the cradle-board the Indian pappoose is subject to any such extreme restraint. The objects in view are facility of nursing and transport, and perfect safety for the child. But those being secured it is nurtured with a tenderness of maternal instinct surpassing that of many savage nations. The infant is invariably laid on its back, but the head rests on a pillow or mat of moss or frayed bark, and is not further restrained in a fixed position than necessarily results from the posture in which the body is retained by the bandages securing it in the cradle. This fact I have satisfied myself of from repeated observations. But the consequence necessarily is, that the soft and pliant bones of the infant's head are subjected to a slight but constant pressure on the occiput during the whole protracted period of nursing, when they are peculiarly sensitive to external influences. Experiments have shewn that at that period the bones specially affected by the action of the cradle-board are not only susceptible of changes, but liable to morbid affections, dependent on the nature of the infant's food. Lehmann supposes the *craniotabes* of Elsässer to be a form of rachitis which affects the occipital and parietal bones during the period of suckling; and Schlossberger ascertained by a series of analyses of such bones that the 63 per cent. of mineral constituents found in the normal occipital bones of healthy children during the first year, diminished to 51 per cent. in the thickened and spongy bone.* The fluctuations in proportion of the mineral constituents of bones are considerable, and vary in the different bones, but in the osseous tissue they may be stated at from 67 to 70 per cent. It is obvious, therefore, that, under the peculiar physiological condition of the cranial bones during the period of nursing, such constant mechanical action as the occipital region of the Indian pappoose is subjected to, must be productive of permanent change. The child is not removed from the cradle-board when suckling, and is not therefore liable to any counteracting lateral pressure against its mother's breast. One effect of such continuous pressure must be to bring the edges of the bones together, and thereby to retard, or arrest the growth of the bone in certain directions. The result of this is apparent in the premature ossification of the sutures of artificially deformed crania.

At Washington I had an opportunity of minutely examining thirty-four Flathead skulls brought home by the United States Exploring Expedition; some of them presenting the most diverse forms of distortion. In the majority of those the premature ossification of the sutures is apparent, and in some they are almost entirely obliterated.—The same is no less obvious among the corresponding class in the collection of the Academy of Natural Sciences of Philadelphia; and especially in skulls of the Chinooks, who carry the process of deformation to the greatest extent. But I have also been struck, not only with the frequent occurrence of wormian bones in such altered skulls, but also with the distinct definition of a true supraoccipital bone.

It is marvellous to see the extraordinary amount of distortion to which the skull and brain may be subjected without seemingly affecting either health or intellect. The coveted deformity is produced partly by actual compression, and partly by the growth of the brain and skull being thereby limited to certain directions. Hales, the Ethnographer of the Exploring Expedition, after describing the process as practised among the Chinooks, remarks: "The appearance of the child when just released from this confinement is truly hideous. The transverse diameter of the head above the ears is nearly twice as great as the longitudinal, from the forehead to the occiput. The eyes, which are naturally deep set, become protruding and appear as if squeezed partially out of the head."* Mr. Paul Kane in describing to me the same appearance, as witnessed by him on the Columbia River, compared the eyes to those of a mouse strangled in a trap. The appearance is little less singular for some time after the child has been freed from the constricting bandages; as shown in an engraving from one of Mr. Kane's sketches of a Chinook child seen by him at Fort Astoria.* In after years the brain as it increases, partially recovers its shape; and in some of the deformed adult skulls one suture gapes, while all the rest are ossified, and occasionally a fracture, or false suture remains open. An adult skull of the same extremely deformed shape, among those brought home by the Exploring Expedition, illustrates the great extent to which the brain may be subjected to compression and malformation without affecting the intellect. It is that of a Nasqually chief, procured from his canoe bier in Washington Territory. (No. 4549.) The internal capacity, and consequent volume of brain, is 95 cubic inches. The head is compressed into a flattened disc, with the forehead receding in a straight line from the nasal suture to the crown of the head, while the lambdoidal suture is on the same plane with the foramen magnum. The sutures are nearly all completely ossified; and the teeth ground quite flat, as is common with many of the tribes in the same region, and especially with the Walla-walla Indians on the Columbia River, who live chiefly on salmon, dried in the sun, and invariably impregnated with the sand which abounds in the barren waste they occupy. I assume the unimpaired intellect of the Nasqually chief from his rank. The Flathead tribes are in the constant habit of making slaves of the Roundheaded Indians; but no slave is allowed to flatten or otherwise modify the form of her child's head, that being the badge of Flathead aristocracy. As this has been systematically pursued since ever the tribes of the Pacific coast were brought under the notice of Europeans, it is obvious that if such superinduced deformity developed any general tendency to cerebral disease, or materially affected the intellect, the result would be apparent in the degeneracy or extirpation of the Flathead tribes. But so far is this from being the case, that they are described by traders and voyagers, as acute and intelligent. They are, moreover, an object of dread to neighbouring tribes who retain the normal form of head; and they look on them with contempt as thus bearing the hereditary badge of slaves.

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* Schlossberger. Arch. f. phys. Heilk. Lehmann, Physiol. Chem. Vol. III. p. 28.

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* Ethnography of the U. S. Exploring Expedition, p. 216.

† Prehistoric Man, Vol. II. p. 320.

The child born to such strange honours is laid, soon after its birth, upon the cradle-board, an oblong piece of wood, somtimes slightly hollowed, and with a cross board projecting beyond the head to protect it from injury. A small pad of leather stuffed with moss or frayed cedar-bark is placed on the forehead and tightly fastened on either side to the board; and this is rarely loosed until its final removal before the end of the first year. The skull has then received a form which is only slightly modified during the subsequent growth of the brain. But the very same kind of cradle is in use among all the Indian tribes. It is indeed varied as to its ornamental adjuncts, and non-essential details; but practically it resolves itself, in every case, into a straight board to which the infant is bound; and as it is retained in a recumbent position, and thus the pressure of its own weight during the period when, as has been shown, the occipital and parietal bones are peculiarly soft and compressible, is made to act constantly in one direction. This, I assume to have been the cause of the vertical or otherwise flattened occiput in the ancient British brachycephalic crania. The same cause must tend to increase the characteristic shortness in the longitudinal diameter, to produce the premature ossification of certain sutures, and to shorten the zygoma, with probably also some tendency to make the arch bulge out in its effort at subsequent full growth, and so to widen the face.

Dr. J. Barnard Davis has applied the term "parieto-occipital flatness," where the results of artificial compression in certain British skulls extend over the parietals with the upper portion of the occipital; and he appears to regard this as something essentially distinct from the vertical occiput.* But it is a form of common occurrence in Indian skulls, and is in reality the most inartificial of all the results of the undesigned pressure of the cradle-board. This will be understood by a very simple experiment. If the observer lie down on the floor, without a pillow, and then ascertain what part of the back of the head touches the ground, he will find that it is the portion of the occiput immediately above the lambdoidal suture, and not the occipital bone. When the Indian mother places a sufficiently high pillow for her infant, the tendency of the constant pressure will be to produce the vertical occiput; but where, as is more frequently the case, the board has a mere cover of moss or soft leather, then the result will be just such an oblique parietal flattenning, as is shown on a British skull from the remarkable tumulus near Littleton Drew, Wiltshire. *Crania Britannica,* Decade III. plate 24.

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* *Nat. Hist. Review*, July, 1862. *Athenæum*, Sept. 27th, 1862, p. 402.

But there are other sources of modification of the human skull in infancy, even more common than the cradle-board. More than one of the predominant head-forms in Normandy and Belgium are now traced to artificial changes; and by many apparently trifling and unheeded causes, consequent on national customs, nursing usages, or the caprices of dress and fashion, the form of the head may be modified in the nursery. The constant laying of the infant to rest on its side, the pressure in the same direction in nursing it, along with the fashion of cap, hat, or wrappage, may all influence the shape of head among civilized nations, and in certain cases tend as much to exaggerate the naturally dolichocephalic skull, as the Indian cradle-board increases the short diameter of the opposite type. Such artificial cranial forms as that designated by M. Foville, the *Tête annulaire,* may have predominated for many centuries throughout certain rural districts of France, solely from the unreasoning conformity with which the rustic nurse adhered to the traditional or prescriptive bandages to which he ascribes that distortion. All experience shows that such usages are among the least eradicable, and long survive the shock of revolutions that change dynasties and efface more important national characteristics.

But now that attention has been directed to the subject of undesigned changes thus effected on the human head, its full bearings begin to be appreciated; and there is even, perhaps, a danger that more may be ascribed to them than is legitimate. Such was undoubtedly the effect on Dr. Morton's mind from his familiarity with the results of artificial deformation on American crania; and were we to follow his example, we should be tempted to designate all the extreme varieties of the elongated dolichocephalic, acrocephalic, and brachycephalic skulls of British barrows, as mere modifications of the same ethnical form.

In his latest recorded opinions, when commenting on some of the abnormal forms of Peruvian crania, he remarks: "I at first found it difficult to conceive that the original rounded skull of the Indian could be changed into this fantastic form: and was led to suppose that the latter was an artificial elongation of a head remarkable for its length and narrowness. I even supposed that the long-headed Peruvians were a more ancient people than the Inca tribes, and distinguished from them by their cranial configuration. In this opinion I was mistaken. Abundant means of observation and comparison have since convinced me that all these variously-formed heads were originally of the same shape, which is characteristic of the aboriginal race from Cape Horn to Canada, and that art alone has caused the diversities among them."* The repeated opportunities I have enjoyed of examining the Mortonian and other American collections, have satisfied me of the occurrence of both dolichocephalic and brachycephalic crania not only as the characteristics of distinct tribes, but also among the contents of the same Peruvian cemeteries,—not as examples of extreme latitudes of form in a common race, but as the results of the admixture either of conquering and subject races, or of distinct classes of nobles and serfs, most generally resulting from the predominance of conquerors.† Among the Peruvians the elongated cranium pertained to the dominant race; and some of the results of later researches in primitive British cemeteries, and especially the disclosures of the remarkable class of chambered barrows, seem to point to an analogous condition of races. That the Uley and West Kennet skulls may have been laterally compressed, while the Codford barrow and other brachycephalic skulls have been affected in the opposite direction, appears equally probable. But such artificial influences only very partially account for the great diversity of type; and no such causes, even if brought to bear in infancy, could possibly convert the one into the other form.

But as the cranial forms, both of the Old and New World, betray evidences of modification by such artificial means; so also we find in ancient Africa a diverse form of head, to which art may have contributed, solely by leaving it more than usually free from all extraneous influences. Such at least is the conclusion suggested to my mind from the examination of a considerable number of Egyptian skulls. Among familiar relics of domestic usages of the ancient Egyptians is the pillow designed for the neck, and not the head, to rest upon. Such pillows are found of miniature sizes, indicating that the Egyptian passed from earliest infancy without his head being subjected even to so slight a pressure as the pillow, while he rested recumbent. The Egyptian skull is long, with great breadth and fulness in the posterior region. In its prominent, rounded parieto-occipital conformation, an equally striking contrast is presented to the British brachycephalic skull with truncated occiput, and to the opposite extreme characteristic of the primitive dolichocephalic skull; though exceptional examples are not rare. This characteristic did not escape Dr. Morton's observant eye; and is repeatedly indicated in the *Crania Ægyptiaca* under the designation, "tumid occiput." It also appeared to me after careful examination of the fine collection formed by him, and now in the Academy of Natural Sciences of Philadelphia, that the Egyptian crania are generally characterised by considerable symmetrical uniformity: as was to be anticipated, if there is any truth in the idea of undesigned artificial compression and deformation resulting from such simple causes as accompany the mode of nurture in infancy.

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* *Physical Type of the American Indian.* Schoolcraft: p. 326.

† *Prehistoric Man,* vol. ii. p. 225.

The heads of the Fiji Islanders supply a means of testing the same cause, operating on a brachycephalic form of cranium; as most of the Islanders of the Fiji group employ a neck pillow nearly similar to that of the ancient Egyptians, and with the same purpose in view: that of preserving their elaborately dressed hair from disshevelment. In their case, judging from an example in the collection of the Royal College of Surgeons of London, the occipital region is broad, and presents in profile a uniform, rounded conformation passing almost imperceptibly into the coronal region. Indeed the broad, well rounded occiput is considered by the Fijians a great beauty. The bearing of this, however, in relation to the present argument depends on whether or not the Fiji neck-pillow is used in infancy, of which I am uncertain. The necessity which suggests its use at a later period, does not then exist; but the prevalent use of any special form of pillow for adults is likely to lead to its adoption from the first. In one male Fiji skull brought home by the United States Exploring Expedition (No. 4581), the occiput exhibits the characteristic full, rounded form, with a large and well defined supra-occipital bone. But in another skull in the same collection, that of Veindovi, Chief of Kantavu, who was taken prisoner by the

United States ship Peacock, in 1840, and died at New York in 1842, the occiput, though full, is slightly vertical. The occipital development of the Fiji cranium is the more interesting as we are now familiar with the fact that an artificially flattened occiput is of common occurrence among the islanders of the Pacific Ocean. "In the Malay race," says Dr. Pickering, "a more marked peculiarity, and one very generally observable, is the elevated occiput, and its slight projection beyond the line of the neck. The Mongolian traits are heightened artificially in the Chinooks; but it is less generally known that a slight pressure is often applied to the occiput by the Polynesians, in conformity with the Malay standard."* Dr. Nott, in describing the skull of a Kanaka of the Sandwich Islands who died at the Marine Hospital at Mobile, mentions his being struck by its singular occipital formation; but this he learned was due to an artificial flattening which the Islander had stated to his medical attendants in the hospital, was habitually practised in his family.† According to Dr. Davis, it is traceable to so simple a source as the Kanaka mother's habit of supporting the head of her nursling in the palm of her hand.‡ Whatever be the cause, the fact is now well established. The occipital flattening is clearly defined in at least three of the Kanaka skulls in the Mortonian Collection; No. 1300, a male native of the Sandwich Islands, aged about forty; No. 1308, apparently that of a woman, from the same locality; and in number 695 a girl of Oahu, of probably twelve years of age, which is markedly unsymmetrical, and with the flattening on the left side of the parietal and occipital bones. The Washington Collection includes fourteen Kanaka skulls; besides others from various Islands of the Pacific, among which several examples of the same artificial formation occur: *e.g.* No. 4587, a large male skull, distorted and unsymmetrical; and No. 4367, (female?) from an ancient cemetery at Wailuka, Mani, in which the flattened occiput is very obvious.

The traces of purposed deformation of the head among the Islanders of the Pacific have an additional interest in their relation to one possible source of South American population by oceanic migration, suggested by philological and other independent evidence. But for our present purpose the peculiar value of those modified skulls lies in the disclosures of influences operating alike undesignedly, and with a well defined purpose, in producing the very same cranial conformation among races occupying the British Islands in ages long anterior to earliest history; and among the savage tribes of America, and the simple Islanders of the Pacific in the present day. They illustrate, with even greater force than the rude implements of flint and stone found in early British graves, the exceedingly primitive condition of the British Islanders of prehistoric times.

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* *Pickering's Races of Man*, p. 45.

† *Types of Mankind*, p. 436.

‡ *Crania Britannica*, Dec. III. pl. 24, (4.)

ON THE MAGNETIC DISTURBANCES AT TORONTO DURING THE YEARS 1856 TO 1862, INCLUSIVE.

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A few years prior to the establishment of the Colonial Magnetic observatories in 1839-40, the attention of philosophers in Germany had been directed to certain magnetic phenomona, consisting sometimes in abrupt changes of short duration, and sometimes in a long continued abnormal condition of the magnetic elements. These disturbances as they are termed, at first attributed to variations in atmospheric temperature and other local causes, were discovered by comparing preconcerted contemporaneous observations to prevail simultaneously, and to correspond in direction, and to great extent also in amount, at different and distant parts of Germany. The improbability of local origin which this synchronism in their occurrence indicated, and the probability wherewith it suggested some extra terrestrial influence, was greatly strengthened by the observations at the observatories at Toronto, Hobarton, &c., which first brought to light the fact that the disturbances occurred simultaneously, not only within a small region in Europe, but also at stations widely removed from each other on the earth's surface. It was found, however, that the disturbing influence would frequently affect different elements at two distant stations, or the same element to a different extent or in an opposite direction.

It was further made known that the disturbances, though in the ordinary sense irregular, are subject in their frequency and aggregate amount to definite periodic laws, manifesting a preference, so to speak, for certain hours of the day and night, and for certain months in the year.

The existence and general charactar of this periodicity was exhibited by the approximate methods employed in the earlier volumes of the colonial observations, but it was by the more accurate system first developed by General Sabine, in the 3rd volume of the Toronto observations, and since applied by him to the observations of other stations, that the periodic laws were rendered definite and precise.

In the method referred to, the disturbed values of an element under discussion, are confined to those which differ from the normal value of that element proper to the hour by an amount equal or exceeding a certain definite limit, such normal being the average of the values of the element for that hour, during a month or some other suitable group of consecutive days, excluding all the disturbed values and including all others; the magnitude of the disturbance being measured by the difference between the actual and the normal value of the element.

The disturbance limit for an element, determined on with reference to the amplitude of its regular periodic variations, is generally different at different stations; but for the sake of inter-comparison must be constant at the same station.

Of the facts revealed by discussing the disturbances at several stations, the following are among the most prominent:—

(1,) The frequency and amount of disturbance of the declination, inclination, and force, have a diurnal and an annual period.

(2,) The disturbances of the elements without regard to sign, the disturbances in which the needle is deflected to the east, and those in which it is deflected to the west of its normal position, as well as the disturbances which increase, and those which decrease the force and inclination, have all distinct and often different periodic laws.

(3,) The periodic variations at different stations, though possessing the same general characters, exhibit in their epochs of maximum and minimum, very great diversities.

(4,) In addition to the diurnal and annual periods, the yearly aggregates of disturbance for each element and at every station are subject to a periodic increase and diminution, occupying a cycle of about ten years, which corresponds both in its length and in the epochs of maximum and minimum, with a periodic variation in the number of groups of spots on the surface of the sun. The disturbances discussed, and the results announced by General Sabine, in the 3rd volume of the Toronto observations, relate to the hourly observations from 1st July, 1843, to 30th June, 1848. It is my purpose in the present communication to give analogous results for the years 1856 to 1862, inclusive, partly to shew that the diurnal and annual variations of the disturbances are substantially the same in the more recent as in the earlier series, but chiefly for the purpose of furnishing materials for discovering the precise character of the so-called decennial period.

In the investigations on which the accompanying tables are based, those disturbances only are included which equal or exceed the limits employed by General Sabine; namely, for the declination, 5′.0; Horizontal force, ·0012; Vertical force, ·00026; Total force, ·0004; Inclination, 1′.0.

In the process of collecting the disturbances of the Horizontal force, additional security has been aimed at, by employing in most instances the observations furnished by two, and in a few cases by three bifilars. The normal for each bifilar being found in the usual way, the difference therefrom of the disturbed readings, and expressed in parts of the Horizontal force, were placed in parallel columns. In the great majority of observations where one instrument gave a disturbed reading the other did so also, but when such was not the case, the blank was filled up by the difference, whatever it might be, between the observed reading and the corresponding normal. The means of the corresponding entries in the different columns being then taken, those were retained as disturbances which equalled or exceeded ·0012.

The disturbances of the horizontal and vertical components of the force being found, the corresponding abnormal deviation $\left(\frac{\Delta\phi}{\phi}\right)$ of the total force and $(\Delta\theta)$ of the inclination were calculated by the formulæ

$$\frac{\Delta\phi}{\phi} = \cos^2\theta\,\frac{\Delta X}{X} + \sin{}^2\theta\,\frac{\Delta Y}{Y}$$

$$\Delta\theta = \tfrac{1}{2}\sin 2\,\theta\left\{\frac{\Delta X}{X} - \frac{\Delta Y}{Y}\right\}$$

Where $\frac{\Delta X}{X}$ and $\frac{\Delta Y}{Y}$ represent the contemporaneous abnormal deviations of the horizontal and vertical components of the force, where one or both of them are disturbed. Of the resulting values of $\frac{\Delta\phi}{\phi}$ and $\Delta\theta$, those and those only were regarded as disturbances, which equalled or exceeded the limits determined on for these elements, namely, ·0004 for the total force, and 1′.0 for the inclination.

The ratios in tables I. and II. are derived from observations in the seven years, commencing 1st January, 1856, and endin 31st Dec.

1862. For the purpose of comparison, the corresponding ratios for the series 1st July, 1843, to 30th June, 1848, and derived from the 3rd Toronto volume, have been introduced. The ratios in table II. are identical with those in the printed volume, but in table I. the aggregate sums at the separate six observation hours, are expressed in terms of the average of the same *six* aggregate sums, whereas in the printed volume, the unit employed is the average of the *twenty-four* aggregate sums.

In table III. the yearly aggregates relate in every case to the year ending 30th June. It has been thus arranged, partly, that the later series might harmonise better with that of 1844–48, and also for the sake of including the year ending 30th June, 1854, and a few of the later months in 1855. The year ending 30th June, 1856, includes for the declination an approximation to the aggregate value of disturbances in July, 1855, calculated on the supposition that it bore to the aggregates in the concluding months of 1855, the same ratio as that founded by the whole series, 1856 to 1862. Approximate values of the disturbances of the vertical force for July, and of the horizontal force, total force, and inclination, both for July and August, 1855, have been similarly found and employed in calculating the aggregates for the year ending 30th June 1856.

In table IV., the sums in table III. have been expressed in terms of the average of the seven yearly sums, terminating 30th June, 1862. These units of reference are employed to show better the periodic character of the last seven years; and though not adapted to exhibit so distinctly the position of the several years, 1844–48, in the decennial period in which the years are included, they render sufficiently apparent the relative magnitude of the aggregates in the two series. Columns 2 and 3 give the results of the observations of M. Schwabe on the solar spots.

On comparing the series 1856–62, in table I., with that of 1844–48 the general correspondence in the ratio is very apparent, the chief characteristic difference in the later series being, that the distinctive features of different parts of the day, as shown in the earlier series, are somewhat softened down; the ratios that are above unity being for the most part less, and those that are less than unity, being greater in the later than the earlier series. In one case only, namely, of the disturbances that increase the horizontal force at 8 a. m., do the ratios lie on opposite sides of unity in the two series; but on referring to table

VIII., page 14 of vol. 3rd, Toronto Observations, we find that the ratios at 9 a. m. and 10 a. m. are 0·94 and 1·46, so that the discrepancy amounts simply to a transfer of the passage through unity from about 9 a. m. to 8 a. m.

In table II., giving the annual distribution of the disturbances, while there is a general resemblance in the ratios of the two series, the maxima and minima, in the more recent series, are less distinctly developed, owing in some measure to the fact that they embrace only the disturbances at six hours, instead of at each of the twenty four hours, and are therefore differently affected by the disturbance *diurnal variation.*

Other points of difference in the two series are the following:

(1,) In five instances the September maximum is transferred to October.

(2,) In nearly every case the April maximum occurs in March, and in the general disturbances of declination, and in those of westerly disturbance the ratio is less than unity.

(3) In every case there is an abrupt decrease in the November disturbances with a subsequent increase in December.

The generality of these points of difference, as far as they extend, will be better seen by comparing the means of the ratios, for the declination, horizontal force and vertical force, as given in the following table.

	January.	February	March.	April.	May.	June.	July.	August.	Septemb.	October.	Novemb.	Decemb.
1844—1848	0.57	0.84	1.04	1.47	1.00	0.46	0.75	0.99	1.64	1.36	0.84	0.65
1856—1862	0.70	0.63	1.10	1.03	0.84	0.74	1.05	1.29	1.60	1.44	0.57	1.01

In the following table is shewn the comparative prevalence of easterly and westerly disturbances of declination in the different months. The ratios indicating the preponderance of easterly and westerly disturbances reach a maximum in June, a minimum in December, a second maximum in March, with a second minimum in April.

	January.	February	March.	April.	May.	June.	July.	August.	Septemb.	October.	Novemb.	Decemb.
1844 to 1848 from 24 observations daily.........	1.29	1.27	1.40	1.04	1.29	3.82	1.41	1 96	1.29	1.21	0.77	0.74
1856 to 1862 from 6 observations daily	0.85	0.86	2.35	1.29	1.84	3.46	1.87	1 53	1.26	0.54	1.15	0.70

The relative amount of easterly and westerly disturbances of declination, and of the disturbances which increase and decrease the total force and inclination, are indicated by the following ratios, whereby it will be noticed, that while the preponderance of easterly over westerly disturbances has increased the preponderance in the disturbances which decrease the force, and in those which increase the inclination, has become much less in the later series.

	Declination East to West.	Hor'l Force Decreasing to Increasing.	Ver'l Force Decreasing to Increasing.	Total Force Decreasing to Increasing.	Inclination Increasing to Decreasing.
1844 to 1848 from 24 observations daily.	1.28	6.4	1.4	1.9	5.6
1844 to 1848 from 6 observations daily.	0.9	5.4	1.5	1.9	
1856 to 1862 from 6 observations daily.	1.28	3.5	1.1	1.4	3.5

In table III. and IV. containing the absolute and relative amount of disturbance in different years, it appears that 1856–57 were years of minimum, and 1860 a year of maximum disturbance. The year 1859 shows a breach of continuity, its disturbances, excepting those of declination, amounting to less than those of 1858 and 1860. If the years commencing January 1st are compared, 1859 becomes the maximum year, but in this case, the disturbances of 1861, are, in in several instances, slightly less than in 1860 and 1862. One striking peculiarity in these tables, consists in the extraordinary amount of disturbances of all the elements in the year ending 30th June, 1854. The observations during that year were taken under rather unfavorable circumstances. Portions of the building were in the course of reconstruction, and workmen with iron tools were much about the premises, but as I have been informed that great care was always taken to ascertain that no iron was left in dangerous proxmity to the instruments during the observations, I cannot ascribe wholly to this cause, the anomalous character of the results. It will be seen, that of the three instrumentally independent elements, the vertical force was most affected, the aggregate in this year of expected minimum actually exceeding that of 1848, the epoch of maximum.

One clue towards the solution of this difficulty may be sought from an examination of the relative magnitudes of the annual mean ranges of the regular diurnal variations of declination, which, according to past experience, correspond very generally with the annual aggregates of disturbance. Taking the amplitudes or ranges, as the angle between the mean positions of the needle, at 8 a. m. and 2 p. m., we have

YEARS.	1844	1845	1846	1847	1848	1853-4	1856	1857	1858	1859	1860	1861	1862
* Amplitudes of diurnal variation of Declination.	7.96	8.60	8.64	8.64	1066	9.03	8.00	8.30	9.69	11.40	12.14	11.92	10.65

It will be here noticed, that although the range in 1853–54 is larger than those of 1844, '45, '46, '47, '56, '57, the preponderance is not such as to warrant any decided inference in explanation of the anomaly in question. It is possible that the disturbance period, which, during the few years that have been examined, has approximately coincided with the decennial period in the appearance of solar spots, may, in addition to the cause thus suggested, be due to some other variable and less powerful influence, the length of whose period may be nearly equal to or nearly a multiple of ten years. Should such an influence exist, the approximate but not accurate superposition of the maxima of the two periods in some cycles, and their interference and antagonism, in others, together with perhaps *local* causes, would account both for the general correspondence and the occasional anomalies.

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* The effects of disturbances are not eliminated from the amplitudes from 1848 to 1860. To render them comparable with those of the subsequent year they should be each increased by about 0'.43.

TABLE I.

Ratios of the aggregate values of the Magnetic Disturbances at each of the six observation hours, derived from a series of years to the average aggregate value of the six hours.

		6 A. M.	8 A. M.	2 P. M.	4 P. M.	10 P. M.	12 P. M.
Declination:							
1844 to 1848	Total	1.03	1.25	0.39	0.51	1.51	1.32
	Easterly	0.50	0.29	0.23	0.35	2.67	1.96
	Westerly	1.53	2.17	0.55	0.67	0.38	0.70
1856 to 1862	Total	1.12	1.07	0.47	0.45	1.46	1.43
	Easterly	0.56	0.35	0.42	0.33	2.40	1.93
	Westerly	1.81	1.97	0.51	0.59	0.29	0.83
Horizontal Force:							
1844 to 1848	Total	1.09	1.21	0.69	0.63	1.07	1.31
	Increasing	0.35	0.30	2.08	2.26	0.62	0.39
	Decreasing	1.22	1.38	0.43	0.33	1.15	1.48
1856 to 1862	Total	1.02	1.08	0.79	0.80	1.05	1.26
	Increasing	0.44	1.02	1.53	1.75	0.64	0.62
	Decreasing	1.19	1.10	0.57	0.53	1.17	1.44
Vertical Force:							
1844 to 1848	Total	1.20	0.80	0.76	1.03	0.84	1.38
	Increasing	0.27	0.41	1.60	2.30	0.91	0.51
	Decreasing	1.86	1.06	0.16	0.14	0.79	1.99
1856 to 1862	Total	1.17	0.83	0.87	1.01	0.88	1.23
	Increasing	0.52	0.54	1.46	1.75	0.98	0.75
	Decreasing	1.79	1.12	0.31	0.30	0.79	1.69
Total Force:							
1844 to 1848	Total	1.31	0.83	0.62	0.93	0.79	1.52
	Increasing	0.26	0.34	1.65	2.56	0.75	0.44
	Decreasing	1.87	1.09	0.07	0.07	0.82	2.09
1856 to 1862	Total	1.28	0.81	0.77	0.98	0.79	1.36
	Increasing	0.33	0.40	1.64	2.17	0.86	0.60
	Decreasing	1.96	1.11	0.15	0.13	0.74	1.90
Inclination:							
1844 to 1848	Total	0.86	1.12	0.89	0.78	1.22	1.13
1856 to 1862	Total	0.93	1.06	0.86	0.87	1.13	1.15
	Increasing	1.02	1.03	0.73	0.71	1.24	1.26
	Decreasing	0.60	1.15	1.32	1.39	0.76	0.78

TABLE II.

Ratios of the aggregate values of the Magnetic Disturbances in the different Months, derived from a series of years to the average aggregate value of all months.

		January.	February	March.	April.	May.	June.	July.	August.	Septemb.	October.	Novemb.	Decemb.
DECLINATION:													
1844 to 1848	Total ...	0.57	0.84	1.11	1.42	0.98	0.53	0.94	1.15	1.62	1.31	0.78	0.76
	Easterly.	0.57	0.84	1.15	1.29	0.98	0.75	0.98	1.36	1.63	1.28	0.60	0.57
	Westerly	0.57	0.84	1.06	1.59	0.98	0.25	0.89	0.89	1.61	1.35	1.06	0.99
1856 to 1862	Total ...	0.59	0.61	0.96	0.91	0.87	0.52	1.08	1.58	1.76	1.42	0.62	1.09
	Easterly.	0.49	0.51	1.22	0.93	1.02	0.73	1.28	1.74	1.78	0.90	0.60	0.81
	Westerly	0.71	0.73	0.64	0.88	0.68	0.26	0.84	1.39	1.74	2.06	0.64	1.43
HOR. FORCE:													
1844 to 1848	Total ...	0.58	0.94	0.94	1.50	0.90	0.36	0.61	0.75	1.71	1.48	0.98	1.28
	Incr'sing.												
	Decr'sing												
1856 to 1862	Total ...	0.72	0.56	1.06	1.03	0.82	0.81	0.99	1.27	1.71	1.47	0.46	1.10
	Incr'sing.	0.40	0.31	0.89	1.29	1.10	1.37	1.52	1.23	1.50	1.06	0.25	1.07
	Decr'sing	0.82	0.63	1.10	0.95	0.74	0.65	0.84	1.29	1.76	1.58	0.53	1.11
VERTICAL FORCE:													
1844 to 1848	Total ...	0.56	0.74	1.08	1.49	1.12	0.50	0.71	1.08	1.60	1.29	0.75	1.00
	Incr'sing.	0.71	0.77	1.21	1.46	0.99	0.51	0.55	0.76	1.49	1.25	0.82	1.48
	Decr'sing	0.45	0.69	0.98	1.55	1.22	0.50	0.95	1.31	1.65	1.33	0.68	0.63
1856 to 1862	Total ...	0.80	0.72	1.27	1.14	0.84	0.88	1.09	1.03	1.34	1.42	0.63	0.84
	Incr'sing.	0.96	0.75	1.32	1.33	0.70	0.90	1.27	0.91	1.29	1.27	0.50	0.80
	Decr'sing	0.64	0.69	1.22	0.95	0.98	0.87	0.91	1.15	1.40	1.57	0.74	0.87
TOTAL FORCE:													
1844 to 1848	Total ...	0.52	0.74	1.05	1.55	1.08	0.39	0.78	1.06	1.64	1.36	0.77	1.05
	Incr'sing.	0.72	0.70	1.17	1.51	1.08	0.45	0.59	0.65	1.45	1.10	0.89	1.67
	Decr'sing	0.43	0.76	0.99	1.56	1.08	0.36	0.88	1.27	1.73	1.49	0.70	0.74
1856 to 1862	Total ...	0.73	0.66	1.29	1.19	0.85	0.83	1.13	1.14	1.50	1.52	0.47	0.70
	Incr'sing.	0.95	0.69	1.33	1.47	0.71	0.91	1.54	0.90	1.31	1.26	0.35	0.58
	Decr'sing	0.57	0.63	1.27	0.99	0.95	0.77	0.84	1.31	1.63	1.70	0.54	0.78
INCLINATION:													
1844 to 1848	Total ...	0.64	0.94	0.97	1.41	0.85	0.39	0.56	0.74	1.67	1.45	1.02	1.37
1856 to 1862	Total ...	0.80	0.58	1.12	0.98	0.79	0.79	0.90	1.19	1.67	1.52	0.49	1.18
	Incr'sing.	0.89	0.66	1.15	0.94	0.70	0.64	0.80	1.21	1.72	1.58	0.52	1.19
	Decr'sing	0.48	0.29	1.02	1.13	1.09	1.28	1.28	1.13	1.47	1.28	0.38	1.17

TABLE III.

Aggregate values of the disturbances in the different years, each ending 30th June.

YEARS.	DECLINATION.			HORIZONTAL FORCE. In parts of the Hor. Force.			VERTICAL FORCE. In parts of the V. F.			TOTAL FORCE. In parts of the Total Force.			INCLINATION.		
	Total.	Easterly.	Westerly	Total.	In-creasing	De-creasing	Total.	In-creasing	De-creasing	Total.	In-creasing	De-creasing	Total.	In-creasing	De-creasing
1844	614′			.1779	.0458	.1321	.1134	.0473	.0661	.1143	.0480	.0663	154.8′		
1845	702			.1523	.0236	.1287	.0994	.0325	.0669	.0699	.0155	.0540	138.0		
1846	771			.2015	.0447	.1568	.1333	.0588	.0745	.1008	.0420	.0592	175.0		
1847	1373			.3986	.0597	.3389	.2226	.0646	.1580	.1940	.0422	.1518	303.4		
1848	1582			.9342	.1161	.8181	.3099	.1624	.1475	.2725	.1123	.1602	789.4		
1849-53	Not pu	blished.													
1854	1494	846′	648′	.5297	.1051	.4246	.3320	.1444	.1876	.2356	.0892	.1464	464.2	354.4′	109.8′
1855	Obser	vations	suspend	ed.											
1856	366	154	212	.2974	.0912	.2062	.1077	.0412	.0665	.0525	.0144	.0381	259.5	168.9	90.6
1857	423	293	130	.2578	.0470	.2108	.1191	.0533	.0658	.0677	.0236	.0441	218.1	174.7	43.4
1858	961	612	349	.8531	.1811	.6720	.2326	.1161	.1165	.1726	.0713	.1013	725.7	571.5	154.2
1859	1200	792	408	.7490	.1671	.5819	.2129	.1220	.0909	.1523	.0732	.0791	641.1	502.8	138.3
1860	1698	882	816	1.3436	.2886	1.0550	.3669	.1668	.2001	.2845	.1062	.1783	1123.4	875.3	248.1
1861	1465	758	707	.9377	.2134	.7243	.2808	.1415	.1393	.2353	.1027	.1326	772.9	606.4	166.5
1862	1118	570	548	.5740	.1178	.4562	.2020	.1025	.0995	.1401	.0627	.0774	513.9	403.4	110.5

TABLE IV.

Ratios of the aggregate values of the Disturbances in different Years, to the average of the aggregate values of the seven years ending June 30, from 1856 to 1862 inclusive.

Years.	Groups of Solar Spots.	Days free from Spots.	Declination.			Horizontal Force.			Vertical Force.			Total Force.			Inclination.		
			Total.	Easterly.	Westerly.	Total.	In-creasing.	De-creasing.	Total.	In-creasing.	De-creasing.	Total.	In-creasing.	De-creasing.	Total.	In-creasing.	De-creasing.
1844	52	111	0.59	..	..	0.25	0.29	0.24	0.52	0.45	0.59	0.72	0.70	0.72	0.25		
1845	114	29	0.68	..	..	0.21	0.15	0.23	0.46	0.31	0.60	0.44	0.23	0.58	0.23		
1846	157	1	0.75	..	..	0.28	0.28	0.28	0.61	0.55	0.67	0.64	0.65	0.64	0.29		
1847	257	0	1.33	..	..	0.56	0.38	0.61	1.02	0.61	1.42	1.23	0.65	1.63	0.50		
1848	330	0	1.53	..	..	1.30	0.73	1.47	1.43	1.53	1.33	1.73	1.73	1.72	1.30		
1849	238	0															
1850	186	2															
1851	151	0	Observ	ations	not yet	publis	hed.										
1852	125	1															
1853	91	4															
1854	67	65	1.45	1.46	1.43	0.74	0.67	0.76	1.53	1.36	1.69	1.49	1.30	1.57	0.76	0.75	0.80
1855	38	146	Observ	ations	suspen	ded.											
1856	34	193	0.35	0.27	0.47	0.42	0.58	0.37	0.50	0.39	0.60	0.33	0.22	0.41	0.43	0.36	0.67
1857	98	52	0.41	0.51	0.29	0.36	0.30	0.38	0.55	0.50	0.59	0.43	0.36	0.47	0.36	0.37	0.32
1858	188	0	0.93	1.05	0.77	1.19	1.15	1.20	1.07	1.09	1.05	1.09	1.10	1.09	1.19	1.21	1.13
1859	205	0	1.16	1.36	0.90	1.05	1.06	1.04	0.98	1.15	0.82	0.96	1.13	0.85	1.05	1.07	1.02
1860	..	..	1.64	1.52	1.80	1.88	1.83	1.89	1.69	1.57	1.80	1.80	1.64	1.92	1.85	1.85	1.83
1861	..	..	1.42	1.31	1.56	1.31	1.35	1.30	1.29	1.33	1.25	1.49	1.58	1.43	1.27	1.29	1.22
1862	..	..	1.08	0.98	1.21	0.80	0.75	0.82	0.93	0.97	0.89	0.89	0.97	0.83	0.85	0.85	0.81

SCIENTIFIC AND LITERARY NOTES.

CLASSIFICATION OF THE SALINE SPRINGS OF CANADA.—BY T. STERRY HUNT, F.R.S.

[The following extract, introductory to a very elaborate review of our mineral springs and river waters, is taken from the revised Report on the Geology of Canada, now passing through the press.]

The mineral waters of Canada may for convenience be arranged in six classes, according to their chemical composition. In the first three classes, chlorids predominate; in the fourth, carbonates; and in the fifth and sixth, sulphuric acid and sulphates. The waters of the first, second, and sixth classes are neutral; those of the third and fourth are alkaline; and those of the fifth are acid.

The first class includes saline waters containing chlorid of sodium, with large portions of chlorids of calcium and magnesium, sometimes with sulphates. The carbonates of lime and magnesia are either present only in very small quantities, or are altogether wanting. These waters are generally very bitter to the taste, and always contain portions of bromids and iodids. Examples,—St. Catherines, Ancaster, Whitby, Hallowell.

The second class includes a large number of saline waters which differ from the first in containing, besides the chlorids of sodium, calcium, and magnesium, considerable portions of bicarbonates of lime and magnesia, the latter carbonate generally predominating. Small quantities of oxid of iron, and of baryta and strontia, are frequently present. These waters generally contain much smaller quantities of earthy chlorids than the first class, and are therefore less bitter, and more pleasant to the taste. Examples,—Plantagenet, St. Léon, St. Geneviève.

The third class includes those saline waters which contain, besides chlorid of sodium, a portion of carbonate of soda, with bicarbonates of lime and magnesia. Small amounts of baryta, strontia, and of boracic and phosphoric acids, are often present in these waters; and bromids and iodids are very rarely wanting. Examples,—Caledonia, Varennes, Fitzroy.

The waters of the fourth class differ from the last in containing but a small proportion of chlorid of sodium, while the carbonate of soda predominates. These waters generally contain a much smaller amount of solid matters than those of the previous classes, and have not a very marked taste until evaporated to a small volume, when they are found to be strongly alkaline. Examples,—Chambly, St. Ours.

The fifth class includes acid waters which are remarkable for containing a large proportion of free sulphuric acid, with sulphates of lime, magnesia, protoxide of iron, and alumina. These springs, which are few in number, and characterized by their acid styptic taste, generally contain some sulphuretted hydrogen. Examples,—Tuscarora and Niagara.

In the sixth class may be included some neutral saline waters, in which the sulphates of lime, magnesia, and the alkalies predominate; chlorids being present only in small amounts. To this class belongs a mineral water from Hamilton, and another from Charlotteville.

CANADIAN INSTITUTE.

ANNUAL REPORT OF THE COUNCIL FOR THE YEAR 1862–63.

The Council of the Canadian Institute have the honor to present the following Report of the proceedings of the Society for the past year:

They regret to have to announce a slight falling off in the list of members, arising chiefly from the unusually small number of names that have been added during the year. In the year 1860, twenty-seven new members were elected; in 1861, thirty-seven; in 1862, twelve. The loss, from various causes, has been twenty-nine, so that the decrease amounts to seventeen.

The present state of the membership is as follows:

Members at commencement of Session, 1861–62		464
New members elected, Session 1861–62		11
By the Council during recess—1861–62		1
Total		476
Deduct—Deaths	6	
Withdrawn	13	
Left the Province	10—	29
Total 30th November, 1862		447
Composed of Honorary Members		4
Life Members		34
Corresponding Members		6
Junior Members		7
Members		396
Total		447

COMMUNICATIONS.

The following list of Papers, read at the Ordinary Meetings held during the Session, will be found to contain many communications of value, and some of general interest:

7th December, 1861.

Prof. D. Wilson, LL.D., "On indications of an Asiatic Origin for the American Race."

P. Freeland, Esq., "Exhibited and Described Wenham's New Binocular Microscope."

14th December, 1861.

Prof. H. Croft, D.C.L., "Exhibited and Described Griffine's Gas Furnace."

Rev. Prof. Hincks, F.L.S., &c., "On a curious variety of Maize from Oregon, with Remarks on some diseased specimens of Maize."

21st December, 1861.

Prof. H. Croft, D.C.L., "A communication upon an old Chemical Joke."

Prof. E. J. Chapman, "On the peculiar conditions of occurrence of certain Canadian Minerals, illustrated by a series of specimens."

18th January, 1862.

Hon. J. H. Hagarty, read "The Annual Address."

Prof. H. Y. Hind, M.A., F.G.S., "A communication embodying Observations made during his Expedition to the Labrador Coast last summer."

25th January, 1862.

Rev. Prof. E. Hatch, B.A., "The Physical Theory of Heracleitus."

1st February, 1862.

Prof. D. Wilson, LL.D., "On apparent traces of Works of Art in the American Drift."

T. C. Keefer, Esq., C.E., "On Ice Phenomena."

8th February, 1862.

Prof. H. Croft, D.C.L., "On Toxicology illustrating the application of Chemical Science in elucidating questions relative to Poisoning Cases in Jurisprudence."

Rev. Prof. Hincks, F.L.S., &c., "Note on a Canadian Specimen of the Sula Bassana (Solan Goose or Gannet)."

22nd February, 1862.

Beverley R. Morris, M.D., "On the Habits of some Water Birds."

Prof. G. T. Kingston, M.A., "The Meteorological Report for 1861."

1st March, 1862.

Rev. Prof. E. Hatch, B.A., "A Sketch of the Pre-Socratic Philosophers."

James Bovell, Esq., "Some recent theories of Cell Developement, with Microscopical Illustrations."

8th March, 1862.

Rev. Prof. G. P. Young, M.A., "Remarks on an argument of Dr. Whewell against the claim of the Parmenides to be considered a genuine dialogue of Plato."

Prof. D. Wilson, LL.D., "On the aim of Shakspeare in his Historical Dramas, as illustrated in his King John."

15th March, 1862.

Prof. H. Croft, D.C.L., "On the supposed existence of Benzole in Canadian Petroleum."

Prof. E. J. Chapman, "A communicution relative to the occurrence of the phenomena of Mock Suns as observed by Mr. Clifford Thomson, P.L.S., near the mouth of the Muskoka River, in November last."

22nd March, 1862.

Prof. E. J. Chapman, "Remarks on some recent announcements and discoveries in Natural Science."

U. Ogden, M.D., "On an atmospheric cause of Disease."

29TH MARCH, 1862.

Rev. Prof. G. P. Young, M.A., "Note on a passage in the Euthyphro of Plato."

5TH APRIL, 1862.

Rev. Prof. E. Hatch, B.A., "On the relation of the Volscian language to others of the Italian Family."

Prof. D. Wilson, LL.D., "On the influence of Mediæval Art on the subsequent forms of Literature."

3RD MAY, 1862.

Lieut. Ormsby, R.A., "On Modern English Guns."

Rev. Prof. E. Hatch, B.A., "On the light which is thrown by the latest results of the Science of Language upon the Early History of Mankind."

The last two papers were originally communicated to the Institute at the Conversazione, which was held at the Music Hall on the 24th of April. The Council believe that, in most respects, the labors of those who superintended the arrangements, and the liberality of those who furnished them with objects of interest for exhibition, were successful in making the meeting a pleasant and instructive gathering to the members of the Institute and their friends; but, to their great regret, it was found, when it was too late to change the place of meeting, that the partially filled hall is not at all suited for public speaking, and the result was that the gentlemen who had kindly consented to read papers could be heard only by a very few persons. In order to meet a generally expressed wish of the members, the Council appointed an Extra-ordinary Meeting on the third of May, when the authors of two of these papers were good enough to give the Institute another opportunity of hearing their valuable communications.

With regard to the papers generally, the Council regret that so small a number of the members of the Institute are to be found in the list of contributors. During the past Session twenty-seven papers have been read, but the number of writers has been only fifteen; and even these numbers do not show the amount of work which has been thrown upon one or two members. The Council would again urge upon the members in general the necessity of increased exertion in this respect, in order that the meetings of the Society may continue to maintain the high character which they have hitherto held.

The Council have to regret the loss of the valuable services of Prof. Chapman as General Editor of the *Journal*. They trust, however, that under the management of Prof. Cherriman it will continue to hold the high reputation which it has already secured. The thanks of the Institute are also due to Prof. Hincks for discharging the duties of Editor during the summer, in the absence of Prof. Cherriman in England.

REPORT OF THE EDITING COMMITTEE.

The Seventh Annual Volume of the New Series of the CANADIAN JOURNAL is now completed, and the Editing Committee submit to the Council of the Institute their annual Report.

They have continued their labours on the same general plan as during preceding years, and they hope the result will not be found unsatisfactory. They wish the *Journal* to be as far as possible supplied with materials by papers read at the meetings of the Institute, and they gladly publish as many of these as are at all suited to their purpose. They have had occasion to regret that during the last Session the proportion was so great of communications which, although highly interesting to the members present, were not designed by their authors for publication, and were either not committed to writing or not placed at the disposal of the Committee.

They are aware that such communications may be, in some cases, useful and acceptable; but they venture to hope that in general those who contribute to the instruction and entertainment of the members will consider those who are absent as well as those who are able to be present, and will place their papers in the hands of the Committee. They would also again express their earnest desire that a greater number of the members of the Institute would manifest their interest in its prosperity by occasional communications on the subjects connected with Literature, Science, the fine or the useful Arts, which engage their attention.

The change in the general editorship during the year, occasioned by Professor Chapman's resignation, owing to his visit to Europe, was only designed as a temporary provision, Professor Hincks having only undertaken the duty in the expectation of being relieved at the close of the year.

Professor Cherriman has, in the mean time, been appointed to the office, and will commence his duties with the January number of the *Journal.*

The cost of the *Journal* for the past year, including printing and engravings, has amounted to $1249.

WILLIAM HINCKS,
General Editor.

TREASURER'S REPORT.

The following is the Report of the Treasurer:

Statement of the Canadian Institute General Account, for the Year 1861–2,—*from* 1*st December*, 1861 *to* 30*th November*, 1862.

Dr.	£	s.	d.	
Cash balance from last year	472	19	11½	
" received from Members	187	7	4	
" " for Journals	47	10	0	
" " for Interest on Loans	101	10	0	
" " Parliamentary Grant for 1862	250	0	0	
" due by Members	422	13	9	
" due for Old Journal	28	5	0	
" due for New Journal	52	16	3	
				1563 2 3½

Cr.	£.	s.	d.			
Cash paid on account of the Journal: 1861, £72 14s.; 1862, £247 8s. 6½d.	320	2	6½			
Cash paid for Library and Museum	96	13	6			
" paid on account of Sundries	252	18	1½			
" due on account of Journal	65	0	0			
" due on account of Sundries	34	4	7			
" due on account of Library	21	16	11			
Estimated Balance	772	6	7½			
				1563	2	8½

The Treasurer in account with the Canadian Institute, for the Yaar 1861-62,—*from* 1*st December*, 1861, *to* 30*th November*, 1862.

Dr.	£	s.	d.			
Cash Balance last year	472	19	11½			
' Securities	1500	0	0			
" Interest received on Securities	101	10	0			
" received from Members	187	7	4			
" " on account of Journals sold	47	10	0			
" Parliamentary Grant, 1862	250	0	0			
				2559	7	3
Cr.						
Cash paid on account of the Journal: 1861, £72 14s.; 1862, £247 8s. 6½d.	320	2	6½			
Cash paid on account of Library and Museum	96	13	6			
" paid on account of Sundries	252	18	1½			
Securities	1500	0	0			
Balance	389	13	1			
				2559	7	3

Statement of the Building Fund.

Balance from last year	2038	11	9			
Received Interest on Loans	101	10	0			
Subscriptions (uncollected)	534	15	0			
				2674	16	9

D. Crawford, *Treasurer.*

Compared Vouchers with Cash Book, the Securities for Investments exhibited. Balance in the hands of the Treasurer, £309 13s. 1d.

Samuel B. Harman, } *Auditors.*
G. H. Wilson, }

10th December, 1862.

In conclusion, the Council think that on the whole they may congratulate the Institute on the results of the past Session. They could wish, indeed, to have had to announce an increase rather than a diminution of numbers; but there seems no reason to fear that this diminution arises from any loss of the public favour, or that it will not be made up by larger accessions in the future. The numbers of a Society which has passed its early period of rapid growth must be expected to be liable to some amount of fluctuation; and the real prosperity of the Institute depends not so much upon its numerical strength as upon the continued interest taken by its members in its proceedings and publications.

APPENDIX.

DONATIONS OF BOOKS, MAPS, &c., SINCE LAST ANNUAL REPORT.

Marked thus * not bound, or pamphlets.

From the Hon. G. W. Allan, M.L.C.

Gould's Trochilidæ. Parts 21, 22, 23, 24, and 25	5*

From the Secretary for India.

Magnetical and Meteorological Observations made at the Government Observatory, Bombay, year 1859	1

From J. Dykes Campbell, Esq.

The early Poems of Mr. Tennyson, privately printed. 1862	1*
Doomsday Book, Cornwall. Photozincographed by Her Majesty's command, at the Ordnance Survey Office, Southampton. 1861	1

From the Superintendent of Education, Lower Canada.

Journal de l'Instruction Publique Cinquieme. Vol. 1861. Journal of Education, Lower Canada, for the year 1861, Both bound in one vol. Cloth	1

From New York State Library.

Catalogue of the Library. 1861. General Library First Supplement. I. Titles; II. Index of Subjects	1
General Index to the Documents relative to the Colonial History of the State of New York. Prepared by E. B. O'Callaghan, M.D.	1

Per Smithsonian Institution, Washington.

Verhandluroger des Zoologisch-botanishen Vereins in Wien,		Band III.	Jahr, 1853	1*
do.	do.	Band IV.	Jahr, 1854	1*
do.	do.	" V.	" 1855	1*
do.	do.	" VI.	" 1856	1*
do	do.	" VII.	Jahrgang, 1857	1*
do.	do.	" VIII.	" 1858	1*
do.	do.	" IX.	" 1859	1*
do.	do,	" X.	" 1860	1*

From the Smithsonian Institution, Washington.

The Smithsonian Miscellaneous Collections. Vols. 1, 2, 3, and 4. 8vo	4*
Annual Report of the Board of Regents of the Smithsonian Institution, for 1861.	1*
Results of Meteorological Observations made under the direction of the United States Patent Office, and the Smithsonian Institution, from the year 1854–59, inclusive. Vol. I., 4to	1

From the Geological Survey of India.

Memoirs of the Geological Survey of India. Vol. III., Part 1	1*
Annual Report of the Geological Survey of India, Fifth Year. 1860–61	1*

From Christopher Walton, Esq., London.

Memorial of William Law, Jacob Böhme, Dio A. Frether, J. G. Gichtel, Francis Lee, and other Theosophers. Printed for private circulation. London, 1854	1
An Introduction to Theosophy; or, the "Mystery of Christ," that is, of Deity, Nature, and Creature, Col. i., 15–20. Vol. I., complete in itself. London: John Kendrik, 27 Ludgate Street	1

From the Provincial Government of Canada.

Statutes of Canada. 1862	1

From the University of McGill Cllege, Montreal.

The University Calendar and Examination Papers. 1862. Corrected to June, 1862	1

From J. Dykes Campbell, Esq.

Leaves from the Back Woods. Montreal: John Lovell. 1861. By Mrs Walker, Sarnia	1

From H. G. Bohn, Esq., London, England.

Aristotle's History of Animals, in ten books. Translated by Richard Cresswell, M.A., St. John's College, Oxford	1
The Roman History of A. Marcellinus, during the reigns of the Emperors Constantine, Julian, Jovianas, Valentinian, and Valens. Translated by C. D. Yonge, B.A., London. 1862	1

From the Manchester Literary and Philosophical Society.

Memoirs of the Society,	1st Series.	Vol. IV., Part II	1
"	"	" V.	1
"	2nd Series.	" III. Part XIV	12
"	3rd "	" I.	1
Proceedings of the Society.		Vol. II. Session 1860–61, and 1861–62	1*
Rules "			1*
Dalton's New System of Chemistry.		Vol. I., Part 1	1
" "		Vol. II., Part 1, with appendix	1
Dalton's Meteorology, 2nd Edition.		1834	1

From Dr. Oldham, Superintendent of the Geological Survey of India.

Memoirs of the Geological Survey of India. Palæontologia. India	1

From Professor James Hall, Albany.

Report on the Geological Survey of the State of Wisconsin. Vol. I. James Hall and J. D. Whitney	1
Report of the Superintendent of the Geological Survey, exhibiting the Progress of the Work, January 1, 1861	1*

From the Society.

Proceedings of the Society of Antiquaries of Scotland. Vol. III., Parts 1, 2, and 3	8*
Proceedings of the Royal Physical Society of Edinburgh, 1854–5, 1855–6	1*

DONATIONS OF PAMPHLETS, SHEETS, &c.

From the Royal University of Christiania.

Karlmagnus Saga ok Kappa Hans. Fortaellinger om Keiser Karl Magnus og Hans Jaevinger. J. Norsk Bearbeidelse, fra det Trettende Aahundrede udgivet af C. R. Unger. II	1
Oversight af Norges Echinodermer, ved Dr. Michael Sars, Profr. ved Christianias Universitet. Med 16 Lithographerede Plancher. 1861	1
Forhandlinger i Videnskabs-Selskabet I. Christiania, aar 1860. Med Lithographerede Plader. 1860	1
Om Siphonodentalium Vitreum en ny Slægt og art af Deutalidernes Familie af Dr. Michael Sars, Profr. vid Christianias Universitet. Med 3 Lithographerede Plancher. 1861	1
Om Kometbanernes Indbyrdes Beliggenhed af H. Mohn. Med Lithographerede Plader. 1861	1
Om Nordmoendenes Landhusholding i Oldtiden af Fr. Chr. Schübeler. 1860.	1
Generalberetning fra Gustad Sindssygeasyl for aaret 1860	1
Om Cislers Berkring af C. M. Guldberg. 1861	1
Samling af Forskjellige Love, Resolutioner, Circulaerer M. V. Vedrorende kongerigit norges Handel og Skibsfart, uedgivet till brug for de forenede Rigers Consular efter Foranstaltning af Departementet for det Indre, &c.	1
Beretning om det kongelige Skelskab for Norges del dets Tisstand og Virksomhed i aaret 1860. Med Bilage	1
Beretning om Bodsfaengstets Virksomhed i aaret 1860	1
Det Kongelige Norske Frederiks Universitets Stiftelese Fremstillet I anledning af dets Halvhundredaarsfest af M. F. Mourad	1

From John Paterson, Esq., Toronto.

Swan Marking. Ordinances respecting Swans, on the River Witham, in Lincolnshire, from 1524	1

From Silliman's Journal.

Professor Hall's rejoinder to the Criticisms of this Journal on his "Contributions to Palæontology" 1

From T. C. Wallbridge, Esq.

Mr. Russell "On Bull Run," with a Note; from the *Rebellion Record* 1

From Col. J. D. Graham, U. S. Topographical Engineers.

Report of Lieut.-Col. J. D. Graham, U. S. Topographical Engineers, on Mason and Dixon's Line, with a Map. Chicago. 1862 1

From Harvard College.

Report of the Committee of the Overseers of, appointed to visit the Library, for the year 1861 1

Unknown. (By Post.)

Hall's Journal of Health. Vol. IX. 1862 1

From the Author.

A Proposal for an Act to authorize the issue of Land Debentures. By Richard Snelling, Student-at-Law 2

The Grand Trunk Railway of Canada, &c., by Richard Snelling, Student at Law 1

From the Author.

On the Rocks lying between the carboniferous Limestone of the lower Peninsula of Michigan, &c., by Alex. Winchell, State Geologist of Michigan.. 1

Geological Survey of Canada.

Descriptive Catalogue of a collection of the Economic Minerals of Canada, and of its Crystaline Rocks, sent to the Exhibition at London, 1862. Printed by John Lovell, Montreal 1

From Smithsonian Institute, Washington.

Beitrâge zur Anatomie und Entwicklungsgeschichte der Algengattung Lemanea, Von B. Wartmann, Dr. Philosopher Bericht über die Thâtigkeit der St. Gallischen, Naturwissenschaftlichen Gesellschaft wâhrend der Vereinsjahre, 1858–60. (Redaktor: Prof. Dr. Wartmann.) 1

do do do. 1860–61 1

Quarterly Journal, Royal Dublin Society, Oct. 1859 1

Unknown Supposed from the Author.

The Miscellaneous writings of W. Sharswood, Vol. one in Memoriam Copy, No. 14, P. P., 1-16 1

Catalogue of the Minerals containing Cerium, by Doctor W. Sarswood, from Proceedings of Boston Nat. His. Soc., Nov. 1861 2

Natural History Society, New Brunswick.

Copy of Regulations and Bye Laws 1

From McGill College, Montreal.

Faculty of Medicine of the University of McGill College, Montreal, 1862-63 1

Unknown.

Poughkeepsie Collegiate School, N. Y. 1

From Hon. P. J. O. Chauveau, Montreal.

Nouville Notè sur les Antiquités Aborigenes trouves â Montreal	1

From Geological Society London, per H. Rowsell, Esq.

Anniversary Address of the President, 21st Feb., 1862	1
Quarterly Journal, Vol. 17, Part 4, Nov. 1861	1
Do " 18, " 1, Feb. 1862	1
Do " " " 2, May, 1862	1

From the Geographical Society, London, per H. Rowsell, Esq.

Proceedings, Vol. V., No. 4, Anniversary Meeting, 27 Jany., 1861	1
" " " No. 5, 1861	1
" " VI., No. 1. 1862	1
" " " No. 2. 1862	1

From the Royal Asiatic Society of Great Britain and Ireland.

Journal of. Vol. 19. Part 1. 1861	1
" " " 2. "	1
" " " 3. 1862	1
" " " 4. "	1

From B. Quaritch, London,

Catalogue Raisonneè of Rare and Valuable Books	12

From the Literary and Historical Society of Quebec.

Transactions of. Vol. V. May, 1862. Part 1.	1

From L. Scott & Co., New York.

Reviews—Westminster, Edinburgh, London, North British, and Blackwood's Magazine for 1862. Each one Set	1

From British North American Association.

Speech of Hon. A. T. Galt, at the Chamber of Commerce, Manchester, 25th September, 1862	1
Rules of the B. N. American Association	1
Public Meeting of do. at the London Tavern, 13 Aug., 1862	1
Letter of Mr. Galt to the Editor of the Times. Published in the daily News, 7th Oct., 1862	1

In Exchange for Journal.

The Journal of Education for Upper Canada, 1862, (Duplicate)	1
The Journal of the Franklin Institute, Philadelphia, 1862	1
The Artizan, London, 1862	1
The Journal of the Society of Arts, 1862, (Duplicate)	1
Silliman's American Journal, 1862	1
Canadian Naturalist and Geologist, 1862	1
Proceedings of the Boston Nat. His. Society, 1862	1
Journal of Education, Lower Canada, 1862	1
Journal de l'Instruction Publique, Lower Canada, 1862	1
The proceedings of the Academy of Natural Sciences, Philadelphia, 1862	1

Historical Recollections of the Essex Institute, 1862	1
Annales Des Mines, &c., France.	
Tome XX., 4th Livraison, 1861, 3rd Serie..	1
“ “ 5th “ “ “ “	1
“ “ 6th “ “ “ “	1
“ XX. 1st “ 1862, 6th “	1
“ “ 2nd “ “ “ “	1
“ “ 3rd “ “ “ “	1
Proceedings of the American Antiquarian Society, Boston	1
The Canadian Agriculturist, 1862	1
Annals of the Lyceum of Natural History, New York, Vol. VII., January to June, 1861	1
The Journal of the Board of Arts and Manufactures	1
Proceedings of Session, 1860 61, of the Royal Society of Edinburgh	1
Transactions of do. Vol. XXII. Part III	1

BOOKS PURCHASED.

	VOLS.
Bacon's Works. Vols. II. III. and IV	3
Smile's Lives of Engineers	2
Sketches of celebrated Canadians and Persons connected with Canada	1
Reports of the British Association from 1831 to 1858	27
The Sea and its Living Wonders. By Dr. G. Hartwig, 2nd edition	1
The Constitutional History of England. By Thos. Erskine May, C. B., in Two Vols. Vol. I	1
The General History of Ceylon. By Sir J. Emerson Tennent	1
Lankester's Lectures on Food	1
“ Uses of Animals to Man	1
Crania Britannica. Decade V	1
New Zealand and its Inhabitant.s By Rev. R. Taylor, M. A	1
Polynesian Mythology and Ancient Traditional History of the New Zealand Race. By Sir G. Grey, late Governor	1
Fiji and the Fijians. By Thomas Williams. Vols. 1 and 2, 2nd edition.	2
A Treatise on some of the Insects injurious to Vegetation. By Thaddeus William Harris, M. D. New Edition enlarged	1
Peter Jones	1
Ure's Dictionary	1

BOOKS BOUND FROM PERIODICALS RECEIVED, &C.

The Mining Journal for 1861	1
Illustrated London News. July to December, 1861; January to June, 1862	1
Athenæum. July to December, 1861; January to June, 1862	2

The Builder. 1861	1
The Art Journal. 1861	1
The Artizan. 1861	1
The London, Edinburgh and Dublin Philosophical Magazine. Vol. 17 and 18. 1859	2
The London, Edinburgh, and Dublin Philosophical Magazine. Vol. 22. 1861	1
" " " " " " 23, 1862	1
The Journal of Education, Upper Canada. Years 1859 and '60	1
The Chemical News. 1861	1
The Proceedings of the Acadamy of Natural Sciences of Philadelphia. Year 1860 and 1861	2
North British Review. 1860-1861	2
The Westminster Review. 1861	1
The Edinburgh Review. 1859-1861	1
Relation Aberge, &c.	1
Journal of the Board of Arts and Manufactures. 1861	1
Silliman's Journal. 1861-1862	2
Journal of the Franklin Institute. January-June 1862	1
Blackwood. July-December. 1861; January-June, 1862	2
Civil Engineers and Architects Journal. 1861	1
North American Review. July and October, 1861	1
Edinburgh New Philosophical Journal. Vol. XV. January-April. 1862	1
Quarterly Journal of the Chemical Society. Vol. 14. April, 1861. January, 1862	1
Historical Recollections of the Essex Institute. Vols. 1, 2 and 3. 1859, '60 and '61	3
Quarterly Journal of the Geological Society. Vol. 17. 1861	1
Annales des Mines	
Journal of the Board of Agriculture, Toronto. 1861	1
Verhandlungendes Zoologisch botanischen vereins in Wein :—	
Band III. Jahr 1853.	1
" IV. " 1854.	1
" V. " 1855.	1
" VI. " 1856.	1
" VII. " 1857.	1
" VIII. " 1853.	1
" IX. " 1859.	1
" X. " 1860.	1
Smithsonian Miscellaneous Collections. Vols. 1, 2, 3 and 4	4
Canadian Journal. 1861	2
Journal of the Board of Arts and Manufactures. 1861	1
Journal of the Royal Geographical Society, England. Vols. 29, 1859; 30, 1860	2
Canadian Naturalist. Vol. 6. 1861	1

MONTHLY METEOROLOGICAL REGISTER, AT THE PROVINCIAL MAGNETICAL OBSERVATORY, TORONTO, CANADA WEST,—DECEMBER, 1862.

Latitude—43 *deg.* 39.4 *min. North. Longitude*—5 *h.* 17 *m.* 33 *s. West. Elevation above Lake Ontario,* 108 *feet.*

Day.	Barom. at temp. of 32°.				Temp. of the Air.				Excess of mean above Normal.	Tens. of Vapour.				Humidity of Air.				Direction of Wind.			Resul't. Direction.	Velocity of Wind.					Rain in inches.	Snow in inches.
	6 A.M.	2 P.M.	10 P.M.	Mean.	6 A.M °	2 P.M °	10PM °	ME'N °	°	6 A.M	2 P.M.	10 P.M.	M'N	6 A.M	2 P.M.	10 P.M.	M'N	6 A. M.	2 P. M.	10 P.M.	°	6 AM.	2 PM.	10 P.M.	Re-sul't.	ME'N		
1	29.532	29.677	29.743	29.6648	33.8	34.9	31.6	33.07	+ 2.28	.173	.159	.156	.162	.89	.78	.87	.85	N N W	N W b N	Calm.	N 44 W	6.1	7.8	0.0	5.14	5.51	...	3.0
2	.858	.908	.827	.8610	21.9	28.4	25.9	24.55	— 5.93	.105	.119	.113	.110	.89	.76	.81	.83	W b N	N W	Calm.	N 63 W	8.5	6.4	0.0	3.80	4.03	...	Inp.
3	.663	.512	.626	.6023	29.8	31.6	23.7	28.08	— 2.00	.147	.147	.105	.131	.88	.83	.82	.84	S E b E	W b S	W	S 12 W	5.4	7.0	1.8	3.10	4.92	...	3.0
4	.608	.548	.477	.5448	28.8	32.7	29.5	29.95	+ 0.17	.121	.143	.136	.130	.76	.76	.83	.78	W b S	W b S	W	S 81 W	6.2	5.8	3.0	5.35	5.45	...	...
5	.478	.366	.238	.3523	24.1	29.1	27.3	26.48	— 2.88	.107	.111	.126	.110	.82	.69	.84	.76	W	W	S W b W	N 73 W	3.8	7.4	7.2	7.86	8.87	...	...
6	.253	.383	.563	.4212	13.6	11.4	4.6	8.97	—20.10	.061	.051	.043	.050	.76	.69	.78	.76	N W b W	N W b W	N N W	N 52 W	22.2	35.5	12.2	21.30	21.52	...	...
7	.702	.759	—	—	—0.8	7.8	—	—	—	.040	.051	—	—	.94	.82	—	—	N W b N	N W b N	N	N 18 W	8.0	6.5	1.5	6.46	6.92	...	...
8	.862	.751	.785	.7968	6.8	24.4	24.8	19.38	— 9.08	.057	.124	.120	.102	.95	.95	.90	.94	N E b N	S S W	S E b S	S 34 E	7.5	9.0	3.8	4.83	7.30	...	3.5
9	.827	.827	.781	.8117	22.3	27.1	27.3	25.53	— 2.62	.107	.128	.126	.122	.89	.87	.84	.88	N E b N	N N W	S W b W	S 70 W	6.5	0.4	14.5	4.72	7.01	...	...
10	.741	.662	.620	.6697	30.6	37.1	36.3	34.72	+ 6.87	.152	.174	.168	.166	.89	.78	.78	.82	S W b W	S W b S	S W	S 49 W	9.0	10.0	9.2	9.94	10.07	...	...
11	.568	.521	.547	.5493	37.4	46.8	42.1	41.60	+13.95	.196	.245	.195	.209	.87	.76	.72	.79	S W	S W	S W b W	S 51 W	13.0	10.8	11.0	11.08	11.68	...	...
12	.716	.777	.785	.7663	38.1	39.9	38.9	38.37	+11.02	.179	.163	.185	.177	.77	.66	.78	.76	N W	S E b S	E b N	N 73 E	7.8	4.0	8.0	5.10	6.10	...	...
13	.747	.604	.609	.6470	37.4	40.3	43.5	40.50	+13.35	.187	.236	.261	.231	.84	.95	.93	.91	E b N	E	S W b S	S 75 E	12.5	2.4	4.2	2.52	5.08	0.240	...
14	.594	.539	—	—	45.4	48.2	—	—	—	.292	.317	—	—	.96	.94	—	—	E S E	Calm.	S E b S	S 22 W	1.5	0.0	1.0	2.14	2.59	0.210	...
15	.336	.203	.135	.2188	47.9	50.0	38.1	44.27	+17 50	.332	.345	.230	.293	.99	.96	1.00	.99	S W	S W b W	N W b N	N 88 W	8.5	0.5	8.4	4.19	6.93	1.250	0.2
16	.125	.206	.469	.2935	34.2	34.9	26.6	31.42	+ 4.85	.185	.125	.119	.135	.93	.60	.82	.75	W b N	W b S	N W b W	N 71 W	8.6	18.5	17.8	14.64	15.69	...	0.5
17	.784	30.014	30.263	30.0313	16.5	19.7	17.2	17.98	— 8.38	.069	.077	.088	.079	.77	.72	.92	.81	N N W	N N W	N	N 23 W	8.6	17.6	5.0	7.38	7.77	...	Inp.
18	30.236	29.922	29.666	29.9132	17.9	29.8	30.2	27.07	+ 0.90	.085	.109	.142	.116	.87	.66	.84	.78	W b N	S W b S	S W	S 39 W	2.5	21.4	13.2	14.63	15.17	...	...
19	29.655	30.011	30.260	30.0045	33.1	17.6	5.3	16.73	— 9.33	.174	.076	.041	.086	.92	.79	.72	.80	W	N W b N	N N W	N 29 W	11.2	24.0	12.5	18.17	18.83	...	...
20	30.393	30.392	30.344	30.3705	—0.8	9.6	8.2	5.30	—20.58	.040	.041	.039	.041	.94	.61	.63	.74	N	N N W	N N W	N 55 W	7.0	2.0	2.2	2.32	3.53	...	...
21	30.184	29.949	—	—	16.5	21.5	—	—	—	.069	.088	—	—	.77	.77	—	—	S S E	E S E	S b W	S 40 E	15.0	7.4	0.8	5.51	5.82	...	0.2
22	29.778	29.587	29.611	29.6547	25.9	38.8	35.6	33.08	+ 7.40	.128	.177	.177	.160	.91	.75	.85	.85	Calm.	W S W	Calm.	S 72 W	0.0	10.2	0.0	4.05	4.58	...	...
23	.732	.848	.982	.8723	33.4	35.6	27.3	31.62	+ 6.05	.171	.167	.126	.148	.89	.80	.84	.82	N N W	N N W	N N E	N 17 E	2.0	3.6	2.2	4.09	6.53	...	...
24	.932	.787	.669	.7778	31.6	33.4	36.0	33.48	+ 8.00	.148	.163	.189	.168	.83	.85	.89	.87	S E b E	E b S	E b N	S 75 E	9.0	11.0	1.0	5.56	5.83	Inp.	...
25	.569	.474	—	—	41.0	46.4	—	—	—	.246	.240	—	—	.95	.76	—	—	S W b S	S W	Calm.	S 52 W	4.5	3.0	0.0	2.47	2.90	...	...
26	.443	.207	.156	.2648	37.1	36.7	35.3	36.30	+11.00	.192	.213	.193	.199	.86	.98	.96	.93	N E	N E b E	N N E	N 23 E	4.8	9.0	3.0	4.14	5.74	0.245	...
27	.346	.460	.495	.4453	35.6	36.3	34.5	34.98	+ 9.70	.193	.176	.181	.178	.93	.82	.90	.88	N W	N W	Calm.	N 76 W	6.5	11.2	0.0	4.15	4.57	...	...
28	.462	.445	—	—	33.8	38.1	—	—	—	.173	.179	—	—	.89	.77	—	—	S W b W	S W b S	S W b W	S 44 W	3.0	10.5	1.5	6.43	6.57	...	...
29	.386	.540	.657	.5457	39.2	39.6	33.1	37.05	+11.88	.190	.176	.167	.177	.79	.72	.88	.80	S W b W	W	N W b N	N 61 W	6.5	9.0	8.8	5.72	7.37	...	...
30	.679	.641	.656	.6612	28.8	28.8	24.8	26.68	+ 1.52	.121	.121	.105	.108	.76	.76	.79	.74	N E b N	N E b E	N N E	N 25 E	6.2	5.2	6.8	7.92	8.20	...	...
31	.760	.857	.980	.8832	16.1	26.2	21.2	21.00	— 4.18	.081	.103	.104	.097	.90	.72	.92	.85	N	S S E	Calm.	N 13 W	7.2	1.8	0.0	0.94	1.98	...	...
M	29.6707	29.6620	29.6902	29.6778	27.73	31.57	28.03	28.78	+ 1.69	.142	.149	.140	.142	.87	.75	.84	.83	....	....	....	....	7.39	9.00	5.18	......	7.58	1.945	10.4

REMARKS ON TORONTO METEOROLOGICAL REGISTER FOR DECEMBER, 1862.

Highest Barometer . . . . 30.453 at 10.30 a.m. on 20th. } Monthly range=
Lowest Barometer . . . . 29.105 at midnight on 15th. } 1.348 inches.

Self-registering Ther.
Maximum temperature . . . . 50°1 on p.m. of 14th } Monthly range=
Minimum temperature . . . . —3°4 on a.m. of 20th } 53°5
Mean maximum temperature . . 34°11 } Mean daily range=10°54
Mean minimum temperature . . 23°57 }
Greatest daily range . . . . . . 23°8 from a. m. to p. m. of 8th.
Least daily range . . . . 2°0 from a. m. to p. m. of 30th.

Warmest day . . . 15th...Mean Temperature . . .=44°27 } Difference=38°97.
Coldest day . . . 20th ...Mean Temperature . . .= 5°30 }
Maximum { Solar . . . . 61°5 on p.m of 11th } Monthly range=
Radiation { Terrestrial . . . . —7°5 on a. m. of 20th } 69°.0
Aurora observed on 0 nights; possible to see Aurora on 7 nights; impossible on 24 nights.
Snowing on 8 days; depth 10.4 inches; duration of fall 30.1 hours.
Raining on 5 days; depth, 1.945 inches; duration of fall, 41.2 hours.
Mean of cloudiness=0.75; Difference from average, 0.0. Most cloudy hour observed, midnight; mean=0.86; least cloudy hour observed, 8 a.m.; mean=0.65.

Sums of the components of the Atmospheric Current, expressed in Miles.

North.	South.	East.	West.
2140.39	1452.08	768.74	3026.44

Resultant direction, N. 73° W.; Resultant Velocity, 3.17 miles per hour.
Mean velocity 7.58 miles per hour.
Maximum velocity 35.5 miles, from 1.30 to 2.30 p.m. on 6th.
Most windy day 6th—Mean velocity 21.52 miles per hour. } Difference 19.54.
Least windy day 31st—Mean velocity 1.98 miles per hour. }
Most windy hour, 10 to 11 a.m.—Mean velocity, 11.13 miles per hour. } Difference
Least windy hour, 10 to 11 p.m.—Mean velocity, 4.76 miles per hour. } 6.37 miles.

6th. Very stormy day; cold and keen.—13th. Mild day; fog 4 to 6 p.m.—14th. Very mild; dense fog all day.—15th. Very mild; dense fog till 9 p.m.—19th. Wind very high, squally and keen.—20th. Almost unclouded; very cold day.—28th. Solar halo 2 p.m.; lunar corona 9 p.m.; lunar halo 10 p.m.

RAPID BAROMETRIC MOVEMENT.

December 15th. Midnight = 29.105 } Ascending range = 1.158 in 46 hours.
17th. 10 p. m. = 30.263 }
20th. 10 a. m. = 30.453 } Descending range = 1.297 in 156 hours.
26th. 10 p. m. = 29.156 }

RAPID THERMOMETRIC MOVEMENT.

December 15th. p.m. 50.0 } Descending range = 53.4 in 114 hours.
20th. a.m. —3.4 }
25th. p.m. 46.6—Ascending range 50.0 in 128 hours.

December, 1862, was comparatively mild and calm; it had more than the mean depth of rain, and less of snow. The amount of cloudiness was exactly the average.

COMPARATIVE TABLE FOR DECEMBER.

YEAR.	TEMPERATURE.					RAIN.		SNOW.		WIND.		
	Mean.	Excess above Average, (26°1).	Maximum observed.	Minimum observed.	Range.	No. of days.	Inches.	No. of days.	Inches.	Resultant. Direction.	Resultant. Velocity.	Mean Velocity
1840	° 24.3	— 1.8	° 41.0	° — 4.4	° 45.4	3	Inap.	18	...	...	...	...
1841	28.7	+ 2.6	45.5	+ 2.4	43.1	7	6.600	5	...	...	...	1.33 lbs
1842	24.7	— 1.4	40.3	+ 3.8	36.5	3	0.880	17	...	...	...	0.60 "
1843	30.0	+ 3.9	41.1	+ 2.7	38.4	6	1.040	8	8.1	...	...	0.53 "
1844	28.2	+ 2.1	48.9	— 0.8	49.7	6	Imp.	6	4.2	...	...	0.40 "
1845	21.1	— 5.0	37.6	— 2.7	40.3	2	Inap.	12	4.7	...	...	0.70 "
1846	27.5	+ 1.4	49.2	+ 3.7	45.5	5	1.215	9	6.0	...	...	0.57 "
1847	30.1	+ 4.0	50.0	+ 6.6	43.4	7	1.185	8	6.8	...	...	0.35 "
1848	29.1	+ 3.0	49.1	+ 0.6	48.5	7	2.750	7	16.5	S 83 W	1.12	5.44 mls
1849	26.5	+ 0.4	41.3	— 5.2	46.5	5	0.840	12	9.6	N 82 W	2.56	6.23 "
1850	21.7	— 4.4	48.3	— 9.7	58.0	2	0.190	18	29.5	N 44 W	2.93	7.40 "
1851	21.5	— 4.6	43.8	—10.5	54.3	6	1.075	15	10.7	N 82 W	4.00	7.37 "
1852	31.9	+ 5.8	51.0	+13.9	37.1	7	3.995	10	20.1	S 69 W	1.03	6.54 "
1853	25.3	— 0.8	42.2	— 5.2	47.4	4	0.625	13	22.3	N 35 W	2.39	4.98 "
1854	21.9	— 4.2	41.8	— 5.9	47.7	5	0.590	12	17.2	N 44 W	4.30	8.56 "
1855	26.8	+ 0.7	45.9	— 2.1	48.0	6	1.845	10	29.5	S 88 W	5.29	11.38 "
1856	22.9	— 3.2	41.2	— 9.1	50.3	6	1.790	20	16.3	S 87 W	4.62	11.56 "
1857	31.9	+ 5.8	45.6	+ 5.7	39.9	7	3.205	14	9.0	N 89 W	2.51	6.84 "
1858	27.4	+ 1.3	43.6	+ 5.0	38.6	11	1.657	18	10.4	N 18 W	1.66	9.36 "
1859	17.9	— 8.2	54.8	— 3.3	58.1	3	1.035	23	37.4	N 53 W	4.29	10.77 "
1860	24.0	— 2.1	38.5	— 7.0	45.5	3	1.362	21	13.5	N 62 W	4.66	10.14 "
1861	31.1	+ 5.0	55.1	+ 5.7	49.4	6	0.560	8	6.8	N 72 W	3.50	7.96 "
1862	28.8	+ 2.7	50.0	— 2.3	52.3	5	1.945	8	10.4	N 73 W	3.17	7.58 "
Results to 1861.	26.11	...	45.26	—0.72	45.98	5.3	1.545	12.9	14.66	N 69 W	2.97	8.18
Exc. for 1862.	+2.67	...	+ 4.74	— 1.58	+ 6.32	— 0.3	+ 0.400	— 4.9	— 4.26	...	...	—0.60

MONTHLY METEOROLOGICAL REGISTER, AT THE PROVINCIAL MAGNETICAL OBSERVATORY, TORONTO, CANADA WEST.—JANUARY, 1863.

Latitude—43 deg. 39.4 min. North. Longitude—5 h. 17 min. 33 sec. West. Elevation above Lake Ontario, 108 feet.

Day.	Barom. at temp. of 32°.				Temp. of the Air.				Excess of mean above Normal.	Tens. of Vapour.				Humidity of Air.				Direction of Wind.			Resultant Direction.	Velocity of Wind.					Rain in Inches.	Snow in Inches.
	6 A.M.	2 P.M.	10 P.M.	MEAN.	6 A.M.	2 P.M.	10 PM	ME'N		6 A.M.	2 P.M.	10 P.M.	M'N	6 A.M.	2 P.M.	10 P.M.	M'N	6 A.M.	2 P.M.	10 P. M.		6 A.M.	2 P.M.	10 PM	Result't.	ME'N		
1	29.973	29.898	29.850	29.9067	26.6°	35.6°	27.3°	29.23°	+ 4.07°	.112	.134	.128	.122	.77	.65	.86	.75	W S W	S W b S	SW b W	S 42° W	6.5	12.0	9.0	8.06	8.18	...	...
2	.758	.672	.626	.6845	29.8	39.9	37.0	35.65	+10.45	.147	.172	.183	.169	.88	.69	.84	.80	Calm.	S S E	Calm.	S 36 E	0.0	1.2	0.0	1.81	2.06	...	...
3	.626	.570	.450	.5373	38.5	43.2	39.9	40.60	+15.45	.199	.235	.233	.219	.86	.84	.95	.86	Calm.	E b S	Calm.	S 78 E	0.0	4.3	0.0	1.25	1.26	0.030	...
4	.230	28.870	—	—	41.7	44.6	—	—	—	.247	.264	—	—	.93	.90	—	—	E b S	E b N	W b S	S 55 W	2.2	3.2	17.0	7.46	11.00	Inp.	...
5	.295	29.282	.221	.2642	35.6	44.3	36.3	38.73	+13.60	.177	.185	.176	.178	.85	.63	.82	.75	S W	S W b S	Calm.	S 56 W	6.5	5.5	0.0	6.01	6.33	0.015	...
6	.166	.183	.302	.2297	36.7	36.0	27.0	32.50	+ 7.37	.197	.118	.129	.146	.90	.56	.88	.79	W b N	W	W N W	N 59 W	9.8	14.0	14.0	16.15	16.92	Inp.	0.1
7	.568	.799	.905	.7828	12.9	18.3	16.1	16.00	— 9.13	.051	.062	.074	.063	.66	.61	.83	.70	N W	NWb N	Calm.	N 33 W	27.5	10.0	0.0	5.93	6.33	...	0.1
8	.954	.914	.955	.9460	18.3	24.4	23.3	22.37	— 2.77	.080	.096	.116	.102	.81	.73	.93	.85	N b E	Calm.	W S W	N 34 E	1.5	0.0	0.6	0.33	1.73	...	4.0
9	.983	.950	.832	.9128	25.2	30.2	32.7	29.72	+ 4.58	.122	.142	.150	.141	.90	.84	.80	.85	N E	S W	S E b E	S 20 E	2.5	0.7	6.5	6.46	6.77	...	0.7
10	.547	.158	.196	.2890	32.7	35.2	34.5	34.63	+ 9.58	.157	.190	.173	.172	.85	.93	.86	.85	S E b E	S b W	W S W	S 37 W	7.7	12.4	13.5	9.54	12.58	0.445	2.0
11	.227	.314	—	—	31.6	30.2	—	—	—	.163	.136	—	—	.91	.80	—	—	W b S	NWbW	N N W	N 59 W	9.0	19.0	15.0	9.34	10.90	...	0.1
12	.771	.660	.885	.7748	12.2	29.1	25.9	23.35	— 1.73	.065	.141	.128	.117	.86	.87	.91	.89	Calm.	S b E	Calm.	N 43 E	0.0	1.2	0 0	1.41	2.31	...	...
13	30.016	.875	.572	.7952	28.4	29.8	33.8	30.70	+ 5.62	.148	.151	.182	.160	.95	.91	.93	.93	N E b E	E	E S E	S 84 E	5.2	16.0	9.0	9.94	10.25	0.250	1.0
14	29.399	.229	.289	.3062	38.5	39.9	35.6	38.13	+13.03	.225	.241	.202	.221	.96	.98	.97	.96	E S E	S W b S	W S W	S 80 W	0.4	5.0	8.0	5.45	7.15	0.255	...
15	.402	.306	.171	.2775	28.8	29.1	24.8	26.47	+ 1.37	.129	.126	.126	.122	.81	.78	.95	.85	NW bN	N N E	N N E	N 10 E	10.0	7.2	12.0	9.89	10.60	...	6.0
16	.061	.164	.525	.2743	8.9	3.1	-0.8	3.08	—21.92	.055	.039	.010	.044	.84	.75	.94	.85	N	NWb N	NWbW	N 21 W	18.0	16.2	6.5	9.73	10.07	...	1.5
17	.888	30.141	30.273	30.1262	-11.2	5.0	6.0	-0.30	—25.32	.024	.044	.049	.039	.86	.79	.85	.86	NW bN	N b E	N N E	N 21 E	0.2	0.8	6.5	4.08	4.18	...	0.2
18	30.348	30.309	—	—	8.2	21.5	—	—	—	.057	.088	—	—	.91	.77	—	—	N E b N	S b E	Calm.	S 33 E	5.0	9.2	0.0	2.41	4.29	...	Inp.
19	30.187	30.134	30.101	30.1385	7.8	30.6	27.0	22.40	— 2.48	051	.138	.129	.110	.82	.80	.88	.86	Calm.	Calm.	N E b N	N 51 E	0.0	0.0	5.5	1.99	2.28	...	...
20	30.020	29.945	29.829	29.9287	29.1	30.6	30.9	30.07	+ 5.22	.141	.160	.164	.153	.87	.93	.95	.91	E N E	E b N	E b N	N 75 E	11.2	18.0	18.5	15.53	15.54	...	1.5
21	29.821	.861	.898	.8635	28.8	32.4	34.2	31.72	+ 6.93	.144	.161	.177	.161	.90	.87	.89	.90	E b N	E N E	E	N 74 E	13.0	9.4	5.8	7.43	7.55	Inp.	0.4
22	.878	.750	.717	.7793	33.4	35.1	34.9	34.30	+ 9.53	.178	.192	.186	.186	.93	.94	.92	.94	S E b E	S b E	SW bW	S 31 W	2.0	2.3	3.4	3.11	3.97	0.012	...
23	.767	.833	.919	.8490	33.4	39.2	34.5	35.05	+10.38	.180	.180	.157	.173	.95	.75	.78	.85	SW b W	N	E	N 78 E	3.4	4.5	14.0	5.88	7.07	...	...
24	.858	.704	.730	.7608	29.5	36.3	38.1	34.93	+10.35	.144	.193	.204	.180	.87	.90	.88	.88	E b N	E	SW bW	S 42 E	14.0	7.2	6.5	2.02	9.35	...	Inp.
25	.849	.834	—	—	36.3	38.1	—	—	—	.168	.145	—	—	.78	.63	—	—	W b S	S W b S	NW bN	S 59 W	10.0	13.8	3.5	4.93	5.82	...	...
26	.785	.579	.548	.6255	29.8	35.6	33.1	32.80	+ 8.32	.147	.193	.182	.174	.88	.93	.97	.93	N b W	S E b E	N N E	N 23 E	5.0	0.8	2.5	3.04	3.49	0.115	1.0
27	.420	.492	.608	.5200	33.1	30.6	27.7	30.10	+ 5.75	.174	.131	.121	.140	.92	.76	.80	.83	N N E	N	N b W	N 11 E	7.0	13.5	4.3	7.03	7.22	...	1.0
28	.634	.615	.517	.5843	24.4	27.0	14.0	21.37	— 2.93	.117	.129	.074	.103	.89	.88	.91	.89	N N W	N b W	N	N 20 W	3.5	3.5	5.2	4.75	4.84	...	...
29	.353	.253	.308	.3012	12.9	28.4	28.7	23.70	— 0.50	.069	.126	.138	.111	.89	.81	.87	.85	NW bN	S W	W b S	S 76 W	4.0	8.0	4.5	3.29	4.13	...	1.0
30	.317	.376	.567	.4325	28.4	35.3	28.4	29.98	+ 5.88	.142	.138	.134	.137	.90	.67	.86	.83	Calm.	W S W	W b N	S 84 W	0.0	6.9	10.5	8.45	8.90	...	...
31	.576	.499	.606	.5668	27.7	33.1	31.6	30.78	+ 6.80	.121	.145	.148	.138	.80	.76	.83	.80	W S W	SW bW	S W	S 54 W	13.5	16.4	10.4	10.87	11.00	...	...
M	29.6675	29.6238	29.6441	29.6466	25.19	31.01	28.24	28.08	+ 3.28	.129	.147	.145	.140	.87	.80	.88	.85	....	....	....	....	6.41	7.81	6.85	......	7.23	1.122	20.6

REMARKS ON TORONTO METEOROLOGICAL REGISTER FOR JANUARY, 1863.

Highest Barometer........................ 30.378 at 10 a. m. on 18th } Monthly range =
Lowest Barometer .... 28.846 at 2.30 p. m. on 4th } 1.532 inches.

Self-regist'ing Thermom. { Maximum Temperature .... 47°0 on p.m. of 4th } Monthly range =
Minimum Temperature ....—14°0 on a.m. of 17th } 61°0
Mean maximum Temperature .... 33°32 } Mean daily range =
Mean minimum Temperature .... 22°93 } 10°38
Greatest daily range ...... 24°6 from a. m. to p.m. of 19th.
Least daily range............ 2°2 from a.m. to p.m. of 6th, and a.m. to p.m. of 15th.

Warmest day......... 3rd... Mean temperature......... 40°60 } Difference = 40°90.
Coldest day .... 17th... Mean temperature.........—0°30 }
Maximum { Solar......................................66°0 on p.m. of 5th } Monthly range =
Radiation. { Terrestrial..............................—22°0 on a.m. of 17th } 88°0
Aurora observed on 3 nights, viz.,—16th, 24th, and 25th.
Possible to see Aurora on 7 nights; impossible on 24 nights.
Snowing on 17 days, depth 20.6 inches; duration of fall, 87.8 hours.
Raining on 10 days, depth 1.122 inches; duration of fall 29.7 hours.
Mean of cloudiness = 0.83. Above average 0.12.
Most cloudy hour observed, midnight, mean = 0.86; least cloudy hour observed, 6 a.m.; mean, = 0.79.

Sums of the components of the Atmospheric Current, expressed in miles.

North.	South.	East.	West.
1732.49	1321.11	1515.41	2248.13

Resultant direction N. 61° W.; Resultant velocity 1.13 miles per hour.
Mean velocity ....7.23 miles per hour.
Maximum velocity .... 30.3 miles, from 3 to 4 a.m. on 6th.
Most windy day ......6th ....Mean velocity, 16.92 miles per hour. } Difference =
Least windy day......3rd ....Mean velocity, 1.26 ditto. } 15.66 miles.
Most windy hour ...3 p.m. to 4 p.m. ....Mean velocity, 8.50 ditto. } Difference =
Least windy hour...2 a.m. to 3 a.m. ....Mean velocity 6.18 ditto. } 2.32 miles.

1st. Solar halo during forenoon; lunar halo at 10 p.m. and midnight.—2nd. Fog at 8 a.m.—5th. Fog at 10 p.m. and midnight.—9th. Lunar halo from 11 p.m.—14th. Fog from 1 p.m. to 2.30 p.m.—16th. Solar halo at 4 p.m.; auroral light at midnight.—22nd. Dense fog at 2 and 4 p.m.—23rd. Fog at 4 p.m.—24th. Auroral light, arch and streamers, 10 p.m. to midnight.—25th. Auroral light from 8 p.m.; lunar halo 8 to 10 p.m.

January, 1863, was very mild, cloudy, and comparatively calm; it had less rain and more snow than the average; and the total amount of moisture was in excess of the mean by 0.402 inches on the surface.

COMPARATIVE TABLE FOR JANUARY.

YEAR.	TEMPERATURE.					RAIN.		SNOW.		WIND.		
	Mean.	Excess above aver'ge (45.5)	Max. ob-served.	Min. ob-served.	Range.	No. of days.	Inches	No. of days.	Inches	Resultant. Direction.	Resultant. V'y.	Mean Force or Velocity.
1840	° 17.0	° — 6.5	° 40.6	° —13.8	° 54.4	4	1.395	11	...	...	...	....
1841	25.6	+ 2.1	41.7	— 4.1	45.8	2	2.150	14	...	...	...	0.36 lbs.
1842	27.9	+ 4.4	45.8	1.3	44.5	5	2.170	9	...	...	...	0.78
1843	28.7	+ 5.2	54.4	1.5	52.9	6	4.295	12	14.2	...	...	0.69
1844	20.2	— 3.3	44.6	— 7.7	52.3	7	3.005	11	24.9	...	...	0.70
1845	26.5	+ 3.0	43.0	— 3.4	46.4	5	Imp.	9	22.7	...	...	0.70
1846	26.7	+ 3.2	41.2	0.3	40.9	5	2.335	10	6.0	...	...	0.55
1847	23.3	— 0.2	42.6	— 2.2	44.8	7	2.135	5	7.5	...	...	1.09
1848	28.7	+ 5.2	51.5	—12.0	63.5	7	2.245	8	7.1	N 82° W	2.03	5.82mls.
1849	18.5	— 5.0	40.1	—15.2	55.3	4	1.175	10	9.2	N 63° W	3.06	6.71
1850	29.7	+ 6.2	46.3	10.6	35.7	5	1.250	8	5.2	N 37° W	0.69	5.80
1851	25.5	+ 2.0	43.2	—12.8	56.0	4	1.275	10	7.8	S 77° W	3.26	7.69
1852	18.4	— 5.1	37.3	— 7.0	44.3	0	0.000	19	30.9	N 68° W	3.14	7.67
1853	23.0	— 0.5	40.9	— 6.6	47.5	1	0.290	6	7.5	N 27° W	2.52	6.34
1854	23.6	+ 0.1	45.2	— 4.3	49.5	7	1.270	11	7.5	N 77° W	2.44	6.91
1855	25.9	+ 2.4	48.2	— 4.7	52.9	5	0.525	13	23.3	N 73° W	1.91	7.26
1856	16.0	— 7.5	33.1	—12.1	45.2	0	0.000	14	13.6	N 75° W	5.24	10.69
1857	12.8	—10.7	34.6	—20.1	54.7	3	Inap.	16	21.8	N 70° W	4.96	10.31
1858	30.0	+ 6.5	45.8	7.5	38.3	6	1.152	11	4.0	N 71° W	2.33	7.40
1859	26.4	+ 2.9	41.5	—26.5	68.0	6	1.449	19	16.4	S 81° W	3.17	8.76
1860	23.4	— 0.1	45.4	— 5.1	50.5	6	0.740	16	8.7	N 89° W	6.09	9.37
1861	19.9	— 3.6	34.5	— 7.0	41.5	4	0.685	23	20.6	N 86° W	2.92	9.30
1862	21.7	— 1.8	42.8	— 1.9	44.7	5	0.115	19	27.4	N 26° W	2.69	8.83
1863	23.1	+ 4.5	44.6	—11.2	55.8	10	1.122	17	20.6	N 61° W	1.13	7.23
Results to 1861.	23.53	...	42.80	—6.52	49.31	4.5	1.407	12	13.63	N 77° W	2.98	7.86
Exc. for 1863.	+ 4.55	...	+ 1.80	—4.68	+ 6.49	+ 5.5	— 0.285	+ 5.0	+ 6.97	....	......	— 0.63

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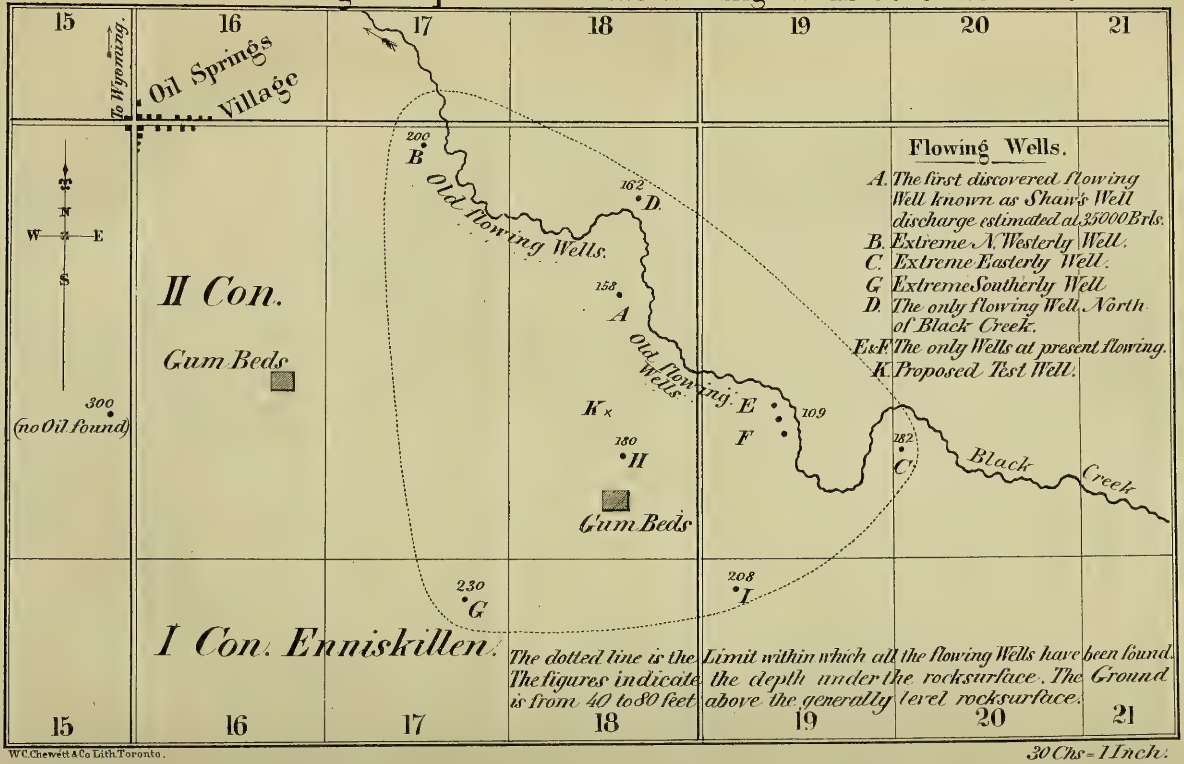
Sketch shewing the position of the flowing Wells at Enniskillen.


15
16
17
18
19
20
21
To Wyoming.
Oil Springs Village
N
W
E
S
300
(no Oil found)
II Con.
Gum Beds
200
B
Old flowing Wells.
162
D.
158
A
Old flowing Wells.
E
F
109
K×
180
H
Gum Beds
182
C
Black Creek
230
G
208
I
Flowing Wells.
A. The first discovered flowing Well known as Shaw's Well discharge estimated at 35000 Brls.
B. Extreme N. Westerly Well.
C. Extreme Easterly Well.
G. Extreme Southerly Well
D. The only flowing Well North of Black Creek.
E&F The only Wells at present flowing.
K. Proposed Test Well.
I Con. Enniskillen.
The dotted line is the Limit within which all the flowing Wells have been found.
The figures indicate the depth under the rocksurface. The Ground is from 40 to 80 feet above the generally level rocksurface.
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16
17
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THE CANADIAN JOURNAL.

NEW SERIES.

No. XLV.—MAY, 1863.

A POPULAR EXPOSITION OF THE MINERALS AND GEOLOGY OF CANADA.

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PROFESSOR OF MINERALOGY AND GEOLOGY IN UNIVERSITY COLLEGE, TORONTO.

PART V.

(Continued from page 127.)

PALÆOZOIC ROCKS OF CANADA.

The formations of Palæozoic age, recognized in Canada, comprise, in ascending order: (1) A complete series of deposits belonging to the *Silurian Epoch;* (2) A succeeding series, referrible to the earlier part of the *Devonian Epoch;* and (3) A partial development of Carboniferous strata—these latter, however, being only found in Gaspé, at the extreme east of the Province.

SILURIAN STRATA:—The Silurian strata are usually subdivided into two series—the *Lower* and the *Upper* Silurians, respectively; but in Canada, the officers of the Geological Survey have recently adopted a third or additional group—the *Middle* Silurians. This latter group includes the lower portion of the Upper Silurian series as originally constituted.*

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* The term "Upper Silurian," it should be observed, is employed in the preceding Parts of this Essay in its original signification; *i.e.*, as including the so-called "Middle Silurians" of the later system of division.

Lower Silurian Series :—This series comprises, in ascending order, the following subdivisions :—1, The Potsdam Group ; 2, the Calciferous Group ; 3, The Chazy Formation ; 4, The Trenton Group ; 5, The Utica Slate Formation ; and 6, The Hudson River Formation.

Note :—The Calciferous and Chazy strata, as regards their occurrence in the neighbourhood of Quebec and throughout the Eastern Townships, are united by Sir William Logan under the term of the Quebec Group. It would also, perhaps, be more in conformity with Nature to unite the three latter divisions, as given above, and to arrange the whole as in the annexed Table. The term "Ontario Group" might be adopted for the proposed union of these higher formations.

Ontario Group.	Hudson River Formation. Utica Formation. Trenton Formation. Bird's Eye and Black River Formation.		
Quebec Group .	Chazy or Sillery Formation. Calciferous or Levis Formation.	=	The higher beds of the Upper Copper-bearing strata of L. Superior (?)
Potsdam Group.	Beauharnois Formation. Kaministiquia Formation. (?)	=	The bottom beds of the Upper Copper-bearing strata of L. Superior (?)

The Potsdam Group :—This subdivision, until a comparatively recent period, was known as the *Potsdam Sandstone*. Its stratified deposits may be arranged under the heads of: deep-sea strata; shallow-sea or shore-line deposits; and altered rocks. Of the deep-sea strata of the Potsdam epoch, merely uncertain indications have at present been obtained. Sir William Logan has suggested that some dark slates which are found to occupy a lower geological position than the Quebec beds of Point Levis,* may very possibly represent some of the deep-sea deposits of that period; whilst it is certain that the ordinary sandstones, of the epoch, were shore-line or coast deposits. This is proved by the presence of ripple marks, and tracks of crustacea or other animals, as well as by the general nature of the sediments of which these sandstones consist. The slates, however, may be of contemporaneous formation with the sandstones: a point at present unsettled. Another series of slate rocks and slaty conglomerates, somewhat resembling those of the Huronian series, associated with beds of chert (a flint-like variety of quartz, sometimes coloured black from the presence of anthracitic matter), grey dolomites, (weathering red), interstratified trap beds, and some argillaceous sandstones, occur in Thunder Bay, and especially near the Grand Falls of the Kaministiquia River, and probably belong to the Potsdam period. They overlie the Huronian rocks in unconformable stratification with these, and hence belong to a succeeding geological epoch. If of Potsdam age, the question again arises as to whether they represent a distinct series, older than the sandstone beds of the east, or whether they are to be considered of the same period of deposition. If older, they might be arranged as in the above table, under the name of the Kaministiquia formation. They are more or less altered by metamorphic action, and contain native copper, iron pyrites, and other metallic matters.

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* In the pronunciation of this word the final letter is mute. Hence the word is often written Lévi.

As the sandstones or shore-line deposits of the Potsdam Group form the most characteristic and widely-spread rocks of the period, as exhibited at least in Canada, it is necessary to refer to them in somewhat greater detail. In the table given above, they are designated as the Beauharnois Formation, from their especial development in the county of that name. They consist essentially of beds of sandstone of various colours, but chiefly white, green, red, brown, or yellowish; and of conglomerates of different degrees of coarseness. Many of the sandstones are fine-grained and of a purely silicious character, and some exhibit bands or stripes of different colours. With these beds, a few layers of dolomite or of more or less impure limestone are occasionally interstratified. Fossils, with the exception of fucoids, are of rare occurrence. In addition to the problematical *Scolithus* (see PART IV., page 97),* the most common is a species of lingula (*L. acuminata*, fig. 155), a genus which thus occurs in the very lowest of our fossiliferous rocks, and which, passing upwards through the entire series of geological formations, is still found in the seas of the existing age. Some remarkable fossil tracks occur also in our Potsdam beds. These belong to two distinct types or genera. The oldest, in point of discovery, were first made known by the late Mr. Abraham, of Montreal, in 1847. They were observed on the surface of a sandstone bed on the St. Louis River, in the County of Beauharnois, and were considered to be the tracks of a tortoise or some related chelonian. The examination of other examples,

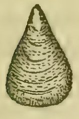
Fig. 155.—*Lingula acuminata* (Conrad).

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* The *Scolithus* cavities figured on this page appear to differ from the common Canadian forms in being longer and more regularly cylindrical. The Canadian type is named *S. Canadensis* by Mr. Billings. (See Revised Report on the Geology of Canada.) p. 101.

however, led to the inference that they were really made by a much lower animal, an extinct crustacean, probably more or less akin to the modern *limulus*. The generic name of *Protichnites* has been bestowed on these tracks by Professor Owen. They present several varieties, but exhibit essentially a narrow and often interrupted central groove with a parallel series of pit-marks on each side, as shewn in fig. 156. The groove is supposed to have been made by the caudal shield or tail-spine of the animal, and the pit-marks by the creature's claws. Tracks of *Protichnites* occur at other localities in Beauharnois, and likewise in Vaudreuil, &c., in Eastern Canada. They have also been found near the Town of Perth in the Township of Drummond, Canada West, where they are accompanied by the second kind of track impressions alluded to above. These latter exhibit narrow bands about five or six inches in width, with "beaded" edges, and usually a central beaded line crossed by a transverse series of curved or straight ridges: the whole presenting, as stated by Sir William Logan, a general resemblance to a rope-ladder. An idea of this appearance may be gleaned from fig. 157. On account of their ladder-like aspect, Sir William Logan has designated these tracks under the generic name of *Climactichnites*. Fig. 157 represents *C. Wilsoni* (Logan), so named from the discoverer of these latter impressions, Dr. Wilson of Perth, to whose explorations Canadian geology is also largely indebted in various other respects.

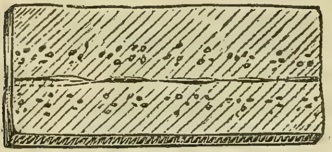

Fig. 156.—*Protichnites alternans* (Owen).

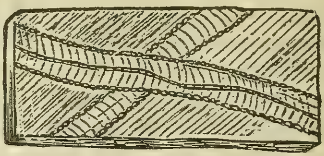

Fig. 157—*Climactichnites Wilsoni* (Logan).

The more important economic materials of the Potsdam Group comprise building stones of good quality, as those from Lyn and Nepean employed in the construction of the Parliament Buildings at Ottawa; sandstones for glass-making purposes, being almost free from oxide of iron (Beauharnois, Vaudreuil),; and sands and sandstones for lining the sides and floors of iron furnaces. The friable sandstone of the Township of Pittsburg (just east of Kingston), and other beds on the St. Maurice in Eastern Canada, are largely used for the latter purpose. To these materials must be added the native copper, native silver, silver glance, amethyst quartz, and sulphate of baryta, contained in the veins which traverse the bottom rocks of the upper copper-bearing series of Lake Superior on the coast and islands of Thunder Bay, as at Prince's Location west of Fort William,* &c.—always supposing the altered rocks in question to be really a portion of the Potsdam Group.

The sandstones and conglomerates of this group are developed chiefly in the Counties of Beauharnois, Vandreuil, Two Mountains, and Berthier in Eastern Canada; and in those of Grenville, Leeds, Lanark, Renfrew, and Carleton in Canada West. A narrow belt occurs also to the west of the gneissoid ridge that crosses the St. Lawrence at the Thousand Isles. This belt runs through the Townships of Pittsburg, Storrington, and Loughborough, and dies out a little to the west of Knowlton Lake. At these various localities the Potsdam beds lie in unconformable position on the upturned edges or between the foldings of the Laurentian rocks. Strata belonging to the Potsdam Group have likewise been traced out, by the officers of the Geological Survey, on the north shore of the Straits of Belle Isle; and the formation is also thought, on good evidence, to occur between the Mingan Islands and the adjacent coast. The thickness of the formation appears to vary from about forty feet or less, in some localities, to six or even seven hundred feet, in others. Interesting exposures occur more particularly at the following places:—Loughborough, Eel, and Knowlton Lakes; north shore of the St. Lawrence, a mile or two below Brockville; north shore and islands of Charleston Lake (Townships of Lansdown and Escott, in Leeds County); vicinity of Beverly in the Township of Bastard; Otty Lake, in Drummond Township, and surrounding district; Townships of Nepean and Gloucester, in Carleton County; Lake St. Louis; Lake of Two Mountains; Point St. Anne and Point du Grand Detour, in Vaudreuil; Lachute, on the Rivière du Nord; River St. Maurice (various parts, near the Cachée, &c.); and Hemmingford Mountain in the Township of that name, on the border line of the Province.† The name of this group is derived from

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* When the earlier portions of this essay were printed, the upper copper-bearing rocks of Lake Superior had not been definitely separated from the underlying and greatly resembling Huronian series. This should be borne in mind with regard to the descriptions of certain minerals in Part II.

† Many interesting details and measurements in reference to these and other localities, will be found in the Revised Report on the Geology of Canada, issued by Sir William Logan and his colleagues.

Potsdam, near Ogdensburg, in the State of New York. This name was applied to it by the New York geologists, long before the Geological Survey of Canada was commenced.

The Calciferous Group :—This division was formerly known as the Calciferous Sand Rock formation, a name bestowed upon it by the New York Survey. The latter term, however, is to some extent a misnomer, since the prevailing or more characteristic strata (in the unaltered districts) are chiefly dolomitic limestones; although many contain, it is true, a considerable amount of sandy or silicious matter. A specimen from Rigaud gave to Prof. Hunt an amount of insoluble matter equal to 36·90 per cent.; and samples from near Prescott, and from the Beauharnois Canal (the latter containing casts of *Ophileta compacta*) yielded to the writer amounts varying from 27·12 to over 40 per cent. Other specimens from near Brockville and elsewhere, left, however, an insoluble residuum of less than 8 per cent.

The rocks of this group may be conveniently discussed under three heads, viz.:—Normal Deposits; Displaced and Altered strata of Eastern Canada; and Altered strata of Lake Superior.

Normal deposits of the Calciferous Group :—In Canada these consist principally of dark-grey dolomitic or magnesian limestones, many containing, as stated above, a certain amount of arenaceous matter. They are also interstratified very frequently with beds of grey, white, or brownish sandstone, varying in thickness from a few inches to four or five feet. The calcareous beds in many districts yield but a poor description of lime, and hence the term "bastard limestones," often applied to them by settlers and others. Small cavities lined or filled with calc spar, or more rarely with quartz, heavy spar, or gypsum, occur in some of the beds; and these and other beds occasionally exhibit in places a coarse concretionary structure. Fossils are of rare occurrence. The most common, perhaps, is the *Ophileta compacta*, fig. 158. Scolithus casts (figured on an earlier page) appear also in certain strata. In Western Canada, these normal Calciferous rocks are apparently unknown west of the gneissoid belt that crosses the St. Lawrence at the Thousand Isles. They may occur, however, in a thin band along

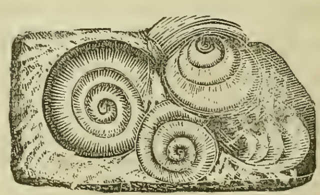

Fig. 158.—*Ophileta compacta* (Salter)

the inner or south-western edge of the outcrop of the Potsdam series in the Townships of Pittsburg and Loughborough, although no certain indications of their presence have as yet been found. On the eastern side of the gneissoid belt, they are somewhat extensively developed—as shewn by the area marked 4 in the map a few pages further on (fig. 249)—although more or less obscured by thick beds of Drift. Exposures occur in the Counties of Leeds, Grenville, Lanark, Renfrew, Carleton, &c., of this district. An important vein of lead ore (galena) occurs in this Formation in the Township of Ramsay, Lanark County. In Eastern Canada, these beds occupy also a considerable area, and occur in the Counties of Beauharnois, Vaudreuil, Two Mountains, Chambly, L'Assomption, &c. They have been discovered likewise, of late years, in the Mingan Islands and on the adjacent coast, a locality in which they have proved more fossiliferous than in other and more western sites.

Displaced and altered Calciferous Rocks:—The displaced strata and altered beds of this age in Eastern Canada, are known more especially as the *Quebec group*. Under this term, however, the succeeding Chazy beds (in an equally altered condition, and which cannot in this district be well separated from the Calciferous deposits) are also included. These strata, until a comparatively recent period, were thought to occupy a somewhat higher place in the Silurian series, or to lie at about the horizon of the Hudson River Formation, near the top of the Lower Silurians. The fossil evidence traced out by the skill and perseverance of Mr. Billings, Palæontologist to the Geological Survey of Canada, first shewed their true position. They consist of a series of grey, black, red, and green shales, in places over a thousand feet in thickness, with interstratified beds of dark and other coloured dolomites, limestones, and sandstones, holding graptolites, brachiopods, trilobites, and other fossils. In this condition, these beds occur

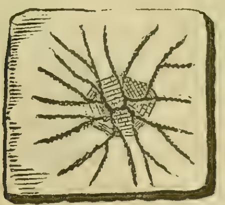

Fig. 159.
Graptolithus Logani (Hall).

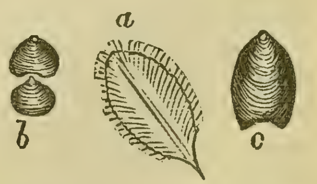

Fig. 160.
a. Phyllograptus typus (Hall).
b. Obolella pretiosa (Billings).
c. Lingula Quebecensis (Billings).

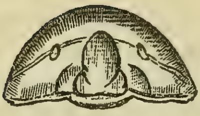

Fig. 161.
Conocephalites Zenkeri (Billings).

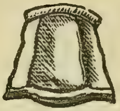

Fig. 162.
Bathyurus Saffordi (Billings).

more especially in the Island of Orleans, near Quebec, and in the district around Point Levis opposite the city. As they extend southwards from the St. Lawrence, both into the Eastern townships and into central Gaspé, and the intervening district, they become greatly altered by metamorphic agencies. The fossils are obliterated; and the shales and other strata are changed into gneissoid, talcose, chloritic, and epidotic schists; and also into fissile slates, serpentines, crystalline marbles, and other analogous rocks. Some of these hold large amounts of copper ore, chromic iron, magnetic and red iron ores, galena, &c.; and the sands and alluvial sediments, derived from their disintegration, contain native gold. (See the descriptions of these minerals in PART II). The unaltered or fossiliferous strata of this series present also an abnormal character, in being forced by a great dislocation and uplift into a position apparently higher than that occupied by the Trenton and other strata of really newer formation. This dislocation or great fault appears to be one of a connected series extending along the whole line of the Appalachian Mountains from Alabama to Eastern Canada. The immediate fracture along the line of which the Quebec Formation has been lifted up, is traced from the vicinity of Lake Champlain to a point just above Quebec, and from thence through the north part of the Island of Orleans, and along the Gulf of the St. Lawrence into the coast of Gaspé. The strata to the south and east of this dislocation are much disturbed, and inclined at high angles, even where they remain (as on the edge of the disturbed region) free from metamorphic or chemical alteration. Many of the rocks, both altered and unaltered, of this region, contain irregular fissures partially filled or lined with a peculiar anthracitic substance usually regarded as an altered bitumen. It is black, more or less lustrous, and usually very brittle. Sometimes (as also in more recent strata) it fills cavities in fossil corals and shells. It occurs more especially around Quebec, in the Island of Orleans, at Point Lévis, and in the townships of Acton, Grantham, St. Flavien, &c. It is occasionally taken for coal; but although chemically of the nature of certain varieties of this substance, it differs from it geologically, and essentially, by never occuring in true or workable beds, but only in irregular masses and narrow veins of no utility. Its ash does not exhibit any traces of vegetable structure, as seen in the ashes of all ordinary coals.

The following are the more important economic substances of the Quebec Group.* *a*) *Copper Ores*:—These comprise chiefly the yellow or common Pyrites, Purple Pyrites, and Copper Glance, occasionally mixed with small portions of native copper and native silver. The ores occur in large irregular or lenticular masses, or in beds, and yield from eight to about eighteen per cent. of metal. Workable quantities are known to exist in the townships of Acton, Upton, Wickham, Durham, St. Flavien, Leeds, Cleveland, Melbourne, Sutton, Chester, Ham, and Garthby; and indications of copper occur in many other localities of this metamorphic region. *b*) *Gold*:—Indications of gold have been met with near the Chaudière Rapids, and in a quartz vein in the township of Leeds. The gold of the alluvial districts will be referred to in connexion with the economic substances of the Drift Formation, as it occurs in the deposits of this latter age. *c*) *Chromic Iron Ore*:—(In beds in serpentine: townships of Ham, Bolton, and Melbourne. Mount Albert: Schickshock Mountains of Gaspé). *d*) *Hœmatitic* and *Magnetic Iron Ores*:—(in beds: townships of Brome and Sutton). *e*) *Galena*;—(Sutton, Chaudière Valley). *f*) *Carbonate of Magnesia*, *Soapstone*, and *Potstone*:—(Sutton, Bolton). *g*) *Marble*;—(Parish of St. Armand (white, black, &c). St. Joseph (red, with white veins). *h*) *Serpentine* and *Serpentine-Marble*:—(Mount Albert, Gaspé; St. Joseph, Beauce Co.; townships of Oxford, Melbourne, &c). *i*) *Roofing Slates*:—(Melbourne, Cleveland, Oxford, Tring, Kingsey. Walton's quarry, near Richmond (Melbourne township), is in active operation. The cost of the slates delivered and loaded on the cars at Richmond, is four dollars per 100 square feet for those of large size (24in. x 12), and two and a quarter dollars for the smaller size (11in. x 6). *j*) *Whetstones*:—(Stanstead, Hatley, Bolton, Kingsey).

Calciferous Strata of Lake Superior:—These strata form the higher beds of the upper copper-bearing series of the lake region,—the lower beds of this series, as explained above, being now generally referred to the Potsdam Group. They consist of quartzose sandstones, red and greenish sandstone conglomerates, various limestones and shales, and interstratified masses of compact and amygdaloidal trap. These beds are also intersected by numerous trap or greenstone dykes; and a vast mass of trap, in places of a basaltic character, generally caps the entire formation. The total thickness of the group is estimated by Sir W. Logan as not far short of 10,000 feet. The cavities in the bedded amygdaloidal traps are filled with agates, amethyst-quartz, calc spar, various zeolites, green earth, epidote, specular iron ore, native copper, &c. Some of the intrusive dykes are porphyritic, and a few consist of syenite. (See PART III). The greenstone dykes present everywhere a transverse columnar structure, and are frequently of great width. As they usually resist the disintegrating action of the water and the atmosphere better than the main body of the rocks which they traverse, they often stand out in relief and form buttress-like masses extending into the lake, so as to produce many natural harbors and breakwaters. The rocks of this series are also traversed by a considerable number of mineral veins belonging, according to the officers of the Survey, to two distinct systems, some being parallel with the range of the strata, whilst others run in a converse direction to this. The veinstones consist usually of calc spar, heavy spar, or quartz; but sometimes of chert or agate, or of the above substances mixed with various zeolites, fluor spar, copper, copper-glance, the common and purple copper pyrites, galena, and blende, in addition to much iron pyrites. The more important metallic sites comprise Prince's Location (native silver and silver glance); Harrison's Location, St. Ignace Island (native copper with native silver); Mamainse (native copper and copper ores); and Michipicotin Island. At the latter locality, native copper (in places slightly argentiferous) occurs not in a vein, but in nodules distributed through a bed of amygdaloidal trap. The other economic minerals of these rocks, include the sulphate of baryta (heavy spar) of Thunder Bay; the amethyst quartz of the same locality; and the agates of Michipicoten and St. Ignace.

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* The reader will find various details of much interest on the copper mines, slate quarries, &c., of the Eastern Townships and other counties of the Quebec Formation, in the Descriptive Catalogue of the Economic Minerals of Canada in the London International Exhibition of 1863, by Sir W. E. Logan.

Exposures of these higher beds of the upper copper-bearing series, occur principally on the south-east side of Thunder Bay, where they form an escarpment of white sandstone (the bottom rock of the higher group) about 200 feet high; also between Thunder Bay and Black

Bay; at Granite Islet, Point Porphyry, Edward Island, the mouth of the Neepigon River, the Battle Islands, St. Ignace, Michipicoten, Cape Gargantua, Batchehwahnung Bay, and Mamainse. (Various interesting details respecting these and other less prominent localities of the rocks in question, will be found in the Revised Report on the Geology of Canada by Sir William Logan and his colleagues.)

The Chazy Formation:—This series of strata derives its name from the town of Chazy, in Clinton county, N. Y. It forms a transition series between the underlying Calciferous beds and the overlying deposits of the Trenton Group. In Canada, it consists principally of grey, brownish-black, and other coloured limestones, with shales and calcareous sandstones, the latter chiefly at the base of the formation. The limestones are sometimes dolomitic, and sometimes bituminous; and they exhibit in places a concretionary structure. Many are highly fossiliferous. Some of the more common fossils comprise *Leperditia Canadensis* (a bivalve entamostracan, fig. 163), and *Rhynconella plena* (a brachiopod, fig. 164). Also, the coral *Stenopora fibrosa* (fig. 165*a*), which ranges into the higher rocks; a peculiar form of uncertain character, *Bolboporites Americanus* (fig. 165 *b*); and *Lingula Lyellii* (fig. 165 *c*). This latter fossil at Allu-

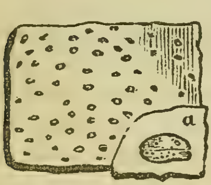


Fig. 163.—*Leperditia Canadensis* (Jones).

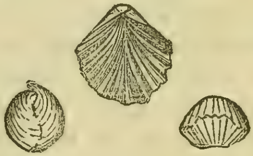


Fig. 164.—*Rhynconella plena* (Hall).

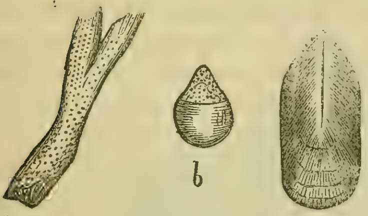


Fig. 165.—*a. Stenopora fibrosa* (Goldfuss).
b. Bolboporites Americanus (Billings).
c. Lingula Lyellii (Billings).

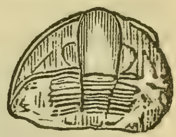


Fig. 166.—*Bathyurus Angelini* (Billings).

mettes Rapids on the Ottawa, is accompanied by numerous dark nodules consisting chiefly of phosphate of lime, and supposed to be coprolites. *Bathyurus Angelini* (fig. 166) is a trilobite belonging to this formation. It has been found in the townships of Huntley, Ramsay, Grenville, &c.

The principal economic materials of the Chazy beds (exclusive of those from the altered rocks of the Eastern Townships as described under the Quebec Group, above: some of these rocks being probably of Chazy age) comprise—a dolomitic limestone from the township of Nepean in Carleton county, yielding the well-known "Hull cement;" grey, and grey-and-red fine-grained limestones, capable of employment as marble, from Caughnawaga, Montreal, the Lake of Two Mountains, St. Dominique, and St. Lin, in Canada East; a thin-bedded limestone, filled with *rhynconella plena*, and largely quarried for tombstones and table-tops, from L'Orignal on the Ottawa; an excellent sandstone for building purposes, from near Pembroke, in Renfrew county, on a higher part of the Ottawa River; and good limestones for the same purpose, from Montreal, Caughnawaga, Hawkesbury, and other localities.

The sandstones of the Sault Ste. Marie and surrounding district, (formerly regarded as belonging to the Potsdam Group), are now thought to be of Chazy age; but otherwise the Chazy formation has not been definitely recognized west of Kingston, although it may perhaps be slightly developed between the Potsdam sandstone and the limestones of the Black River formation in the townships of Storrington and Loughborough. In the area east of Kingston, between the Ottawa and the St. Lawrence, it occurs somewhat extensively. Exposures are seen in the townships of Nepean, March, Ramsay, Huntley, Hawkesbury, &c., of that region. It occurs also largely on the other side of the Ottawa, in the townships of Chatham, Grenville, Longueuil (Prescott county), and especially around the city of Montreal. It is found likewise in places farther east, between that point and the River Chicot; and again in the Mingan Islands.

The Trenton Group:—This group derives its name from Trenton in New York. The lower beds of the group have been separated from the higher beds, and referred to two distinct formations, called, respectively, the Bird's Eye and the Black River Limestones; but in Canada, a separation of this kind cannot be definitely carried out. As certain fossils, however, are restricted *locally* to the bottom beds of the group, or are more especially characteristic of these, the terms Bird's Eye and Black River Limestone, or the latter alone, is occasionally employed in reference to the beds in question: thus partially recognising two sub-formations, the Bird's Eye and Black River (united) below, and the Trenton proper, above. The strata of the entire group average from 600 to 700 feet, and consist almost wholly of limestones, usually of a grey or black colour, and more or less bituminous. Here and there a bed of sandstone, rarely exceeding two or three feet in thickness, and a thin seam of calcareous clay, may occur amongst the series; but limestone rocks essentially characterize the formation. Some of these are thick, and others thin-bedded, the latter passing into limestone shales. Fossils are exceedingly abundant in most of these beds. Those more especially characteristic of the lower sub-division, comprise:—*Tetradium fibratum* (fig. 167), *Columnaria alveolata* (fig. 168), *Stromatopora rugosa*

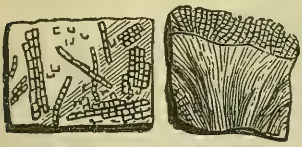


Fig. 167.—*Tetradium fibratum* (Safford).

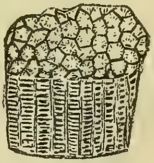


Fig. 168.— *Columnaria alveolata* (Goldfuss).

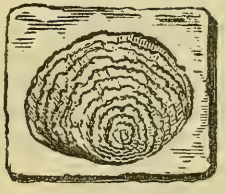


Fig. 169.—*Stromatopora rugosa* (Hall).

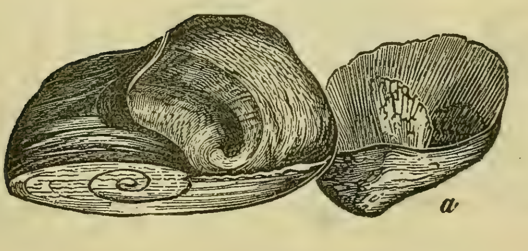


Fig. 170.—*Maclurea Logani* (Hall).

(fig. 169), *Maclurea Logani* (fig. 170), *Ormoceras* (Orthoceras) *tenuifilum* (fig. 171), *Ormoceras* (Gonioceras) *anceps* (fig. 172), and other orthoceratites with beaded siphuncle (see *ante*, PART IV.) Also species of *Lituites, Cyrtoceras,* and *Phragmoceras* (figs. 173, 174, and 175).

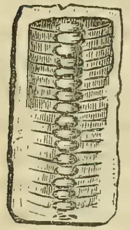


Fig. 171.—*Ormoceras tenuifilum* (Hall).

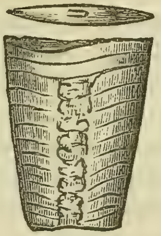


Fig. 172.—*Ormoceras anceps* (Hall).

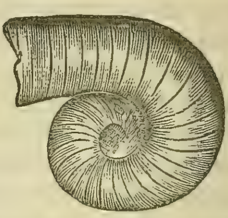


Fig. 173.—*Lituites undatus* (Hall).

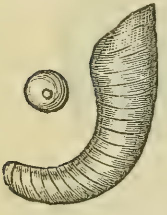


Fig. 174.—*Cyrtoceras annulatum.*

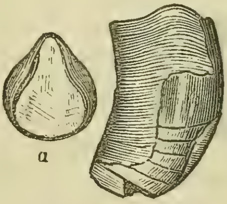
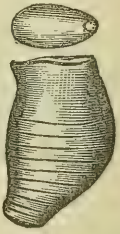


Fig. 175.—*Phragmoceras præmaturum* (Billings).


Fig, 176.—*Oncoceras constrictum* (Hall).

The more characteristic or otherwise interesting fossils of the Upper or Trenton subdivision, properly so-called, are exhibited in the following figures. The zoological positions and affinities of these have already been indicated in PART IV.

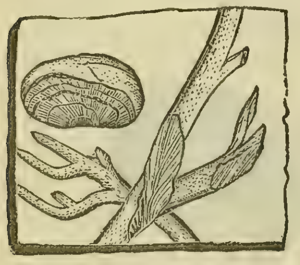


Fig. 177.—*Stenopora fibrosa** (Goldfuss).

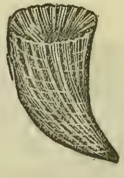


Fig. 178.—*Petraia cornicula* (Hall).

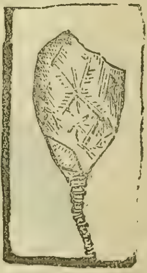


Fig. 179.—*Glyptocystites Logani* (Billings).

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* The circular varieties of this coral are sometimes known as *S. petropolitana.*

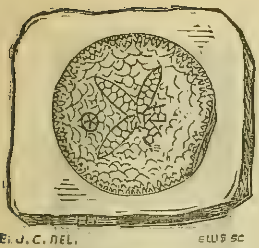

Fig. 180.—*Agelacrinites Billingsii* (Chapman).

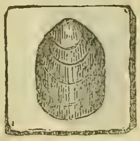

Fig. 181.—*Lingula quadrata* (Hall).

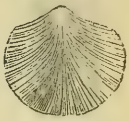

Fig. 182.—*Orthis testudinaria* (Dalman).

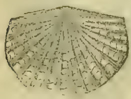

Fig. 183.—*O. pectinella* (Conrad).

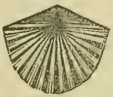

Fig. 184.—*O. tricenaria* (Conrad).

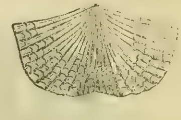

Fig. 185.—*O. lynx* (Eichwald).

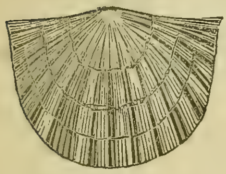

Fig. 186.—*Strophomena alternata* (Conrad).

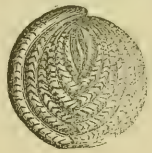

Fig. 187.—*Rhynconella increbescens* (Hall).

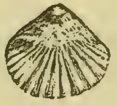

Fig. 188.—*Camerella hemiplicata* (Billings).

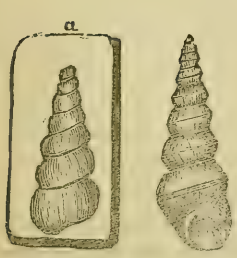

Fig. 189.—*Murchisonia gracilis* (Hall).

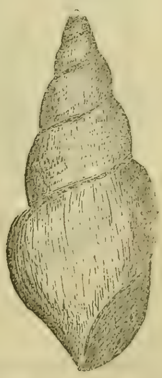

Fig. 190.—*M. subfusiformis* (Hall).

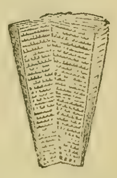

Fig. 191.—*Conularia Trentonensis* (Hall).

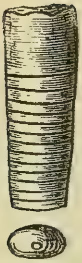

Fig. 192.—*Orthoceras lateralis* (Hall).

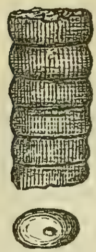

Fig. 193 —*O. bilineatum* (Hall).

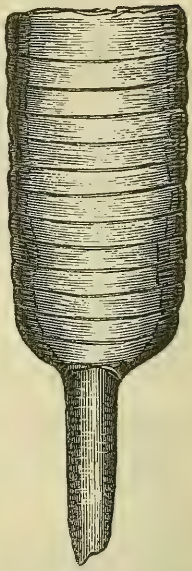

Fig. 194.—*Endoceras proteiforme* (Hall).

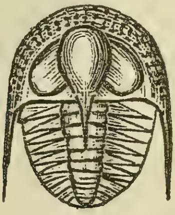

Fig. 195 —*Trinucleus concentricus* (Eaton).

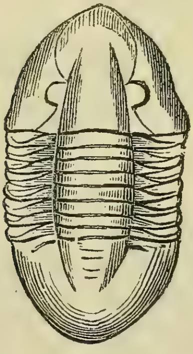

Fig. 196.—*Asaphus platycephalus*† (Stokes).

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† *Asaphus megistos*, from Cobourg, is a closely related species, but with the posterior angles of the head-shield prolonged into horns. See *ante*, Part IV.

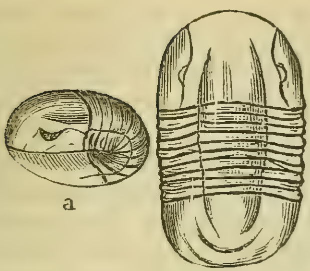

Fig. 196 *a.*=*Illænus crassicauda* (Hall).

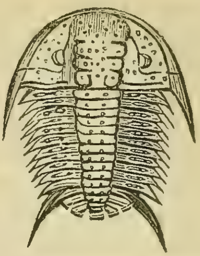

Fig. 197.—*Ceraurus pleurexanthemus* (Green).

Some of the limestones of the Trenton Group are sufficiently fine-grained to take a good polish, and hence to be employed as marble. To these belong, more especially, a dark or chocolate-brown variety from the River Mississippi in the township of Pakenham (Lanark Co.), and grey varieties from the township of Gloucester (Carleton Co.), and from Montreal. Good building stones are quarried in La Chevrotière (the so-called Deschambault stone, of which the principal buildings in Quebec are constructed), at Montreal, Point Claire, Mille Roches in Cornwall township, Kingston, Ox Point near Belleville, Cobourg, Lake Conchiching north of Lake Simcoe, and various other localities. The Lake Conchiching stone is highly silicious, and consequently difficult to dress, although exceedingly durable. Excellent lime is also obtained from most of the limestones of this group. A thin light-coloured bed belonging to the lower part of the series, and which may be traced with slight interruption from Marmora to Lake St. John in the township of Rama, yields also a lithographic stone of useful quality. Near the mouth of the Coldwater River on Georgian Bay, likewise, a thin greenish sandstone, quite at the base of the series, has been long used by the Indians for the manufacture of pipe-bowls, &c. It is easily worked at first, being comparatively soft until after exposure for some time to the atmosphere.

The limestones of the Trenton Group are extensively developed in both Western and Eastern Canada. In the former (see the Map, fig. 249, in which this group is denoted by the number 6), they occur largely in the counties of Prescott, Russell, Carleton, Renfrew, Lanark, &c., between the Ottawa and the St. Lawrence, and especially around Ottawa City; but they occupy a still more extensive area on the west side of the Laurentian belt, already so frequently alluded to as separating the Silurian deposits of the basin between the two rivers, from the same deposits of the region west of Kingston. In this latter district, they form the north shore of Lake Ontario to the neighbourhood of Cobourg, and stretch northwards into the townships of Loughborough, Portland, Camden, Hungerford, Madoc, Marmora, and Dummer; and northwestward along the southern outcrop of the Laurentian rocks up to near the mouth of the River Severn on Georgian Bay,—a line of small lakes occurring for a great part of this distance between the highly-tilted gneissoid strata and the nearly horizontal Black River and Trenton beds. From a little west of Cobourg, the other or more westerly limit of the Trenton outcrop runs also to the north-west, and comes out on Georgian Bay a short distance west of Collingwood. The whole of Lake Simcoe, with Balsam, Rice, and other smaller lakes, lies thus within the Trenton area; but the country is much covered by drift deposits, so that exposures of rock are not of very frequent occurrence except along the northern limit of the formation as given above, and at these points, the Black River or lower subdivision is chiefly exposed. The upper or Trenton beds, on the other hand, come out chiefly on Lake Ontario. Still farther to the west, the formation runs across the northern portions of Manitoulin Islands, and is also seen in Lacloche, Mississague, the Snake, and other smaller islands, along the north shore of Lake Huron. It occurs finally on the north part of St. Joseph Island at the entrance of St. Mary's River. The underlying sandstone of this island, as well as the sandstone beds of Sault Ste. Marie, formerly referred to the Potsdam series, are now looked upon as representatives, in this region, of the Chazy formation.

In Eastern Canada, exposures of the Trenton Group occur more particularly at and around the village of Caughnawaga, on the south bank of the St. Lawrence; at Point Claire; around Montreal; on Isle Jésus, Isle Bizard, &c.; at St. Lin, and in the environs of that village; at St. Rocque and other places on the Achigan, as well as on the rivers Naquarean, Bayonne, and Chaloupe, and here and there between these points and the River St. Maurice; at various places in the seigniories of Portneuf, Deschambault, and La Chevrotière; at Pointe aux Trembles on the St. Lawrence; Quebec and its vicinity; around the Montmorenci Falls; on the River Ste. Anne; at Cape

Tourmente and Cape Aux Rets; on the Gouffre river; in the seignory of Les Eboulemens; at Murray Bay; and at Lake St. John on the Saguenay. These localities of the Trenton Group in Eastern Canada, with others of less importance, are described very fully in Sir William Logan's Revised Report on the geology of the Province.

The Utica Formation:—This subdivision (named after the City of Utica in the State of New York) is generally known as the Utica Slate Formation. It comprises a series of dark-brown bituminous shales, interstratified here and there with a few beds of dark limestone. The shales weather light-grey, and yield by decomposition a soil of much fertility. In Western Canada, the entire thickness of the formation is under one hundred feet; but in parts of Canada East, it is at least three times that amount. Considerable difficulty, however, is experienced in separating the Utica beds from the overlying deposits of the Hudson River Group, and sometimes, also, from the underlying Trenton strata—certain fossils ranging throughout the three groups, and beds of passage occurring likewise between these. Anthracitic matter, as in many other of our rock formations, is occasionally found in thin coatings on the surface of the shale beds. In some districts, as in the townships of Collingwood and Whitby, C.W., these shales are sufficiently bituminous to yield profitable amounts of mineral oil and gas for illuminating purposes. The Collingwood shales have afforded about twenty gallons of oil to the ton; but the distilleries of that place have now ceased working, chiefly in consequence of the large and cheap supply of mineral oil furnished to commerce by the "oil-wells" of the West.

The following figures exhibit the more characteristic fossils of the Utica formation.

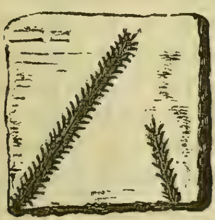

Fig. 198.—*Graptolithus pristis* (Hisinger).

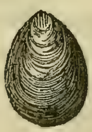

Fig. 199.—*Lingula obtusa* (Hall.)

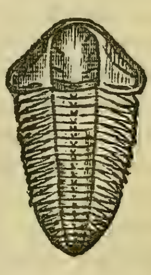

Fig. 200.—*Triarthrus Becki* (Green).

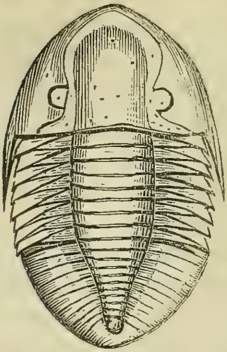

Fig. 201.—*Asaphus Canadensis* (Chapman).

In addition to the above forms, several species of brachiopods, which occur also in both the Trenton and Hudson River Groups, are also frequently met with. The most abundant of these comprise: *Orthis testudinaria* (fig. 182), *Strophomena alternata* (fig. 186), *Rhynconella increbescens* (fig. 187), and *Leptæna sericea* (fig. 204).

In Western Canada, the Utica formation (No. 7 on the map, fig. 249) occupies a small area in the immediate vicinity of Ottawa city, another in the township of Cumberland, and a third in Clarence and Plantagenet (Counties of Russell and Prescott); but it is far more extensively developed in the geological region on the western side of the gneissoid belt which crosses the St. Lawrence at the Thousand Isles. In this region, it forms the shore of Lake Ontario from a little west of Cobourg to the township of Pickering, and sweeps from these points to the north-west, coming out at Georgian Bay in the townships of Nottawasaga and Collingwood. Within the intervening space, however, it is entirely obscured by a thick capping of Drift deposits. It appears also in a narrow band in the Manitoulin Islands, more especially in the neighbourhood of Cape Smyth; and is obscurely seen on St. Joseph's Island. The best exposures in Western Canada, occur near Ottawa City; on and adjacent to the shore of Lake Ontario, in the township of Whitby; in Nottawasaga Bay under the "Blue Mountains," a few miles west of Collingwood Harbour; and at Cape Smyth and some of the neighbouring bays and small islands of the Manitoulin group.

The formation in Eastern Canada, presents in many localities a considerable developement. Exposures occur at Montreal, and in the vicinity of that city, where the shales are much penetrated by trap dykes; also on the Richelieu River, and in the adjoining district; here and there on the north shore of the St. Lawrence, between Montreal and Quebec, as on the St. Maurice and Achigon rivers; largely in the vicinity of Quebec itself, and more especially about Beauport and the Falls of Montmorenci, and along the north shore of the Island of Orleans; again near Cape Tourmente; and at Lake St. John on the Saguenay.

The Hudson River Formation.—The strata of this sub-division in Western Canada, consist essentially of arenaceous shales. These are chiefly of a bluish or greenish-grey colour, but become brown by weathering. They are occasionally interstratified with layers of ordinary sandstone, and with a few beds of limestone—their extreme thickness being about 700 feet. In Eastern Canada, the formation consists also in chief part of shales of a similar character, mixed with subordinate beds of bituminous shale, conglomerate, and limestone. Its thickness in the vicinity of Quebec is estimated at about 2000 feet; but in Western Canada, it does not exceed 700 or 750 feet in thickness. Many of its fossils are identical with those of the Trenton and Utica groups; but certain forms are peculiar to it; and others (such as *ambonychia radiata, modiolopsis modiolaris, &c.*) although occasionally occurring in the Trenton group, are more particularly characteristic of the present formation. The accompanying figures represent some of the most important of these fossilized remains.

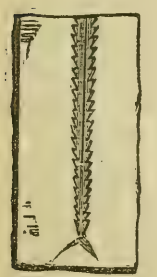

Fig. 202.—*Graptolithus bicornis* (Hall.)

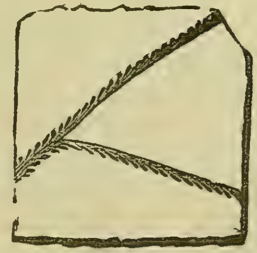

Fig. 203.—*G. ramosus* (Hall.)

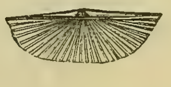

Fig. 204.—*Leptæna sericea* (Sowerby.)

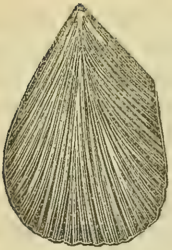

Fig. 205.—*Ambonychia radiata* (Hall.)

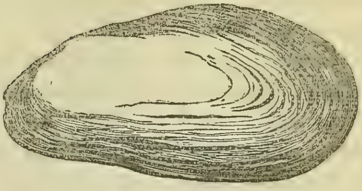

Fig. 206.—*Modiolopsis modiolaris* (Conrad).

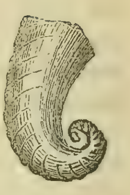

Fig. 207.—*Cyrtolites ornatus* (Conrad)

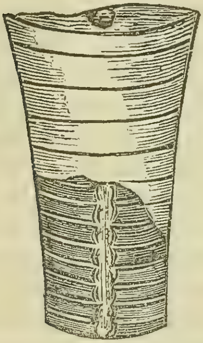

Fig. 208.—*Orthoceras crebriseptum* (Hall).

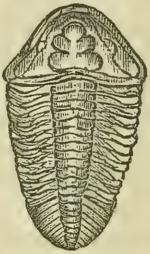

Fig. 209.—*Calymene Blumenbachii* (Brogniart).

In addition to the above, the following species (figured under the Trenton Group, on a preceding page) are also of common occurrence :—*Stenopora fibrosa* (fig. 177) ; *Petraia cornicula* (fig. 178) ; *Orthis testudinaria* (fig. 182) ; *Strophomena alternata* (fig. 186) ; *Rhynconella increbescens* (fig. 187) ; *Orthoceras bilineatum* (fig. 193) ; *O. lateralis* (fig. 192) ; *Trinucleus concentricus* (fig. 195) ; *Asaphus platycephalus* (fig. 196) ; *and Illænus crassicauda* (fig. 196 *a*).

In western Canada, the Hudson River formation occurs as an outlier in the vicinity of Ottawa City, associated with the bituminous shales of the Utica series. Its chief development in this section of the Province, however, is between the more western extremity of Lake Ontario, and the Western shores of Georgian Bay. It forms the shore-line of Lake Ontario from the River Rouge in the Township of Pickering (Ontario Co.), to the River Credit in Toronto township (Peel Co.); and sweeps from these points to the north and north-west, coming out on Georgian Bay in the townships of Collingwood, St. Vincent, Keppel, and Albemarle. Lonely Island and the other islands between Cabot's Head and the Manitoulins are also composed of Hudson River strata; and the formation runs through the Manitoulin group, and across Drummond Island—reappearing in Sulphur Island, and on the north shore of St. Joseph's Island, from whence it passes into Michigan. Instructive exposures, from which many fossils may be collected, occur more particularly on the banks of the Don, Humber, Mimico, Etobikoke, and Credit, along the southern outcrop of the formation. Also at Point Boucher in Nottawasaga Bay; Point Rich, Point William, Cape Crocker, and Point Montresor, further west along the coast. On Lonely and Rabbit islands, at Cape Smyth, and various points along the north shore of the great Manitoulin; and on the northern headlands of Cockburn Island.

In Eastern Canada, the formation is exposed more particularly on the banks of the Richelieu, about Chambly, and on the Rivière des Hurons and the Yamaska, these rivers probably running, according to Sir William Logan, on three parallel anticlinals. Also on the south shore of the St. Lawrence, between St. Nicholas and the Rivière du Chêne; around Quebec, and largely at the Montmorenci Falls; and on the north side of the Island of Orleans. It has been discovered also on Snake Island, Lake St. John; and likewise on the coast of Gaspé, between Cape Rosier and the River Marsouin, and more especially about the Magdalen River. Finally, the Hudson River Formation occurs in force along the north coast of the Island of Anticosti, where it is principally composed, however, of argillaceous limestone. The remarkable fossil bodies named *Beatricea* by Mr. Billings, were discovered at this locality, and also at Lake St. John, some years ago, by Mr. Richardson of the Geological Survey. These fossils resemble petrified fragments of the trunks and limbs of large trees. Their true nature is still doubtful, but they are generally regarded as belonging to an extinct genus of corals.

The Hudson River formation is not rich in economic materials, but it yields in places some tolerably good flagging stones. At the "Blue Mountain," in Collingwood township, whetstones of fair quality are also obtained from this formation; and certain strata near Quebec furnish a good hydraulic cement. A very strong cement has likewise been manufactured from a dark dolomitic bed of this age, occurring on the Magdalen River, in Gaspé.

Middle Silurian Series. The rocks of this series, as explained on a preceding page, originally formed part of the Upper Silurian division. They have been separated from the latter, by the officers of the Canadian Geological Survey, in consequence of certain peculiarities connected with their occurence in the Island of Anticosti. In this island, situated at the entrance of the St. Lawrence Gulf, the rocks in question contain fossils belonging to both the Lower and Upper Silurians (as occurring elsewhere), and thus appear to offer a traditional series, or middle term, between these two divisions.* They compose the "Anticosti group" of Sir W. E. Logan, with the overlying Guelph deposits; and present, in ascending order, the following formations:—(1.) The Medina and Clinton Formation; (2.) The Niagara Formation; and (3.) The Guelph Formation. These, as regards Western Canada, might fairly be grouped together, under the term of the *Niagara Group.*

Medina and Clinton Formation.—In the State of New York, the rocks of this subdivision constitute two more or less distinct sets of strata; but in Canada, the upper or Clinton series merges on the one hand into the underlying Medina beds, and, on the other, into the succeeding Niagara series. Its deposits consequently are partitioned off between these two formations, the term "Clinton" being, however, retained to designate the higher strata of the first or lowermost of these. Thus defined, the Medina and Clinton subdivision consists in Canada of red and green arenaceous shales, succeeded by a coarse and somewhat loosely consolidated sandstone of a red colour, with overlying soft red marls and shaly beds, striped and spotted with green, and capped by a bed of grey sandstone (known as the "grey band,") of from ten to twenty feet in thickness. These strata, about 614 feet in thickness at the western extremity of Lake Ontario, constitute the Medina series proper. The succeeding Clinton beds comprise a series of green, greyish, and red shales—the latter, highly ferruginous—with some interstratified limestones and dolomites. At the mouth of the Niagara River, the Clinton division, as thus defined, is merely a few feet thick; but it increases in thickness towards the north-west, and attains to about 180 feet on the shores of Georgian Bay, by Cabot's Head.

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* The same holds good however, to some extent, in other localities.

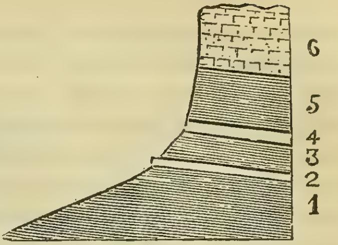


Fig. 210.

In the annexed section, 1 indicates the higher portion of the Medina beds; 2, the grey band, which forms the upper limit of this series; 3, the Clinton strata; and 4, 5, and 6, the succeeding calcareous beds of the Niagara formation. In the Medina deposits, fossils are exceedingly rare. They appear with us to be limited to fucoids, and to a single species of lingula of a triangular or cuniform outline (*L. cuneata.*) The most characteristic fucoid is the *Arthrophycus Harlani,* (fig. 211), a form which occurs also, and more abundantly, in the Clinton beds. These latter contain, in addition, various corals, brachiopods, trilobites, &c.; many of which, however, belong likewise either to the succeeding Niagara formation, or to some of the Hudson River or Trenton beds of the Lower Silurian series. Some of the most abundant comprise: *Stenopora fibrosa,* (fig. 117,) *Heliopora fragilis,* (fig. 212,) *Favosites Gothlandica,* (fig. 214,) *Strophomena rhomboidalis,* (fig. 232,) *Orthis lynx,* (fig. 135,) *O. elegantula,* (fig. 218,) *Spirifer radiatus,* (fig. 220,) *Atrypa reticularis,* (fig. 240,) and *Calymene Blumenbachii,* (fig. 209.)

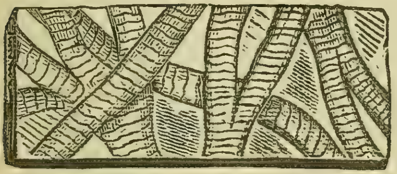


Fig. 211.—*Arthrophycus Harlani* (Hall.)

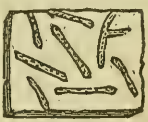


Fig. 212.—*Heliopora fragilis* (Hall.)

This formation (Nos, 9 and 10, the latter denoting the upper or Clinton beds, in the sketch map, figure 249) constitutes the greater portion of the south shore of Lake Ontario, and sweeps round the western extremity of the lake, by Hamilton, &c., to within a short distance of Oakville. From these points, it runs in a general northerly and north-westerly direction through East and West Flamborough, Nelson, Caledon, &c., up to the western extremity of Georgian Bay, where its higher strata form the lower and middle portion of the promontory of Cabot's Head. From Queenston, where it enters Canada, along the whole of this distance, the formation is capped by an escarpment or cliff-face of the succeeding Niagara strata; whilst the "grey band" at the top of the Medina subdivision proper, stands out in many places as a distinct terrace below the sloping bank formed by the out-cropping but debris-covered edges of the Clinton beds. Further to the west, the formation is seen in the Manitoulin Islands. Some of the more instructive exposures occur at Queenston, and in the gorge of the Niagara river; at the Welland Canal in Thorold; at St. Catherines; near Jordan in Louth township; on Stoney Creek, in Saltfleet; at Hamilton; Wellington Square; Dundas and its neighborhood; Waterdown in East Flamborough; Georgetown; Esquesing; on the River Credit in the township of Caledon; on several creeks in Nottawasaga; at Owen Sound and on the Sydenham River; and at Cape Commodore and along part of the adjacent coast up to Cabot's Head.

In Eastern Canada, the Medina and Clinton formation has not been definitely recognised; but Sir William Logan states that an escarpment of red shales overlying the Hudson River series, on the south shore of the St. Lawrence, between the rivers Nicolet and Gentilly, together with another restricted patch of a similar character, in that district, may very probably be referred to the Medina division.

The only important economic materials belonging to the formation, are derived from the Grey Band at the top of the Medina beds, and from a dark dolomitic limestone of the Clinton subdivision. The former yields an excellent building stone, and also grindstones of good quality, (Hamilton, Dundas, Waterdown, Georgetown, &c.,); whilst from the latter, about Thorold and St. Catherines more especially, a strong water-lime (known as Thorold cement) is largely manufactured.

The Niagara Formation:—The group of strata thus named, includes, in Canada, the upper portion of the Clinton subdivision as recognized by the geologists of the New York Survey, together with

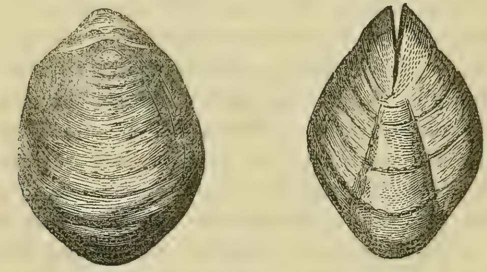


Fig. 213.—*Pentamerus oblongus* and *Internal cast.*

the Niagara beds proper. Thus defined, the formation consists at its lower part of about twenty feet of dark-grey limestone (in part dolomitic, and in which the well-known *Pentamerus oblongus*, fig. 213, first appears), followed by a considerable thickness of dark, more or less bituminous, thin-bedded limestones or calcareous shales, which in their turn are overlaid by dark, thick-bedded limestones, also of a bituminous character. These relations are shewn in the sections, fig. 210: beds 4, 5, and 6. At the Falls of Niagara, the calcareous shales make up a thickness of about 80 feet, and the thick-bedded strata which succeed, and over which the cataract breaks, exhibit about the same amount; but in adjoining localities it attains a thickness of 165 feet. Thin bands of gypsum occur in both the shales and limestones; and the latter contain, in various places, small cavities and fissures filled with crystals of calc spar, pearl spar or dolomite, gypsum, blende, galena, &c. They often enclose, also, peculiar casts of somewhat doubtful origin. The general form of these is shewn in figure 214. Casts of this kind occur not only in the present formation, but likewise occasionally in the Trenton limestones, and in the strata of the Onondaga and various other groups. They are generally known as *crystallites* or *epsomites,* and have probably been formed by the infiltration of carbonate of lime into spaces previously occupied by crystalline masses of sulphate of magnesia or soda, or of some other soluble mineral. Many of the Niagara beds are exceedingly rich in fossils. Some of the more characteristic of these (in addition to the *Pentamerus oblongus* depicted above) are shewn in the following figures:—

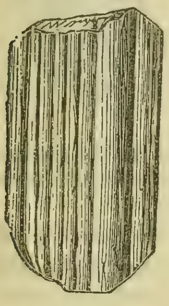


Fig. 214.

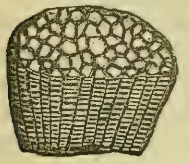


Fig. 215 —*Favosites Gothlandica* (Goldfuss).

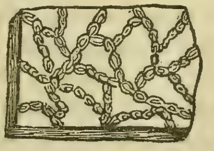
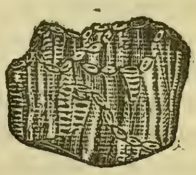


Fig. 216.—*Halysites catenulatus* (Linnæus).



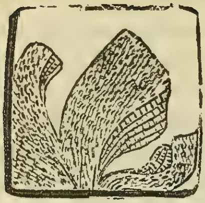


Fig. 217.—*Fenestella elegans* (Hall).

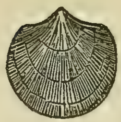


Fig. 218.—*Orthis elegantula* (Dalman).

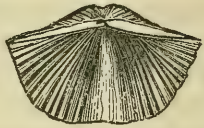


Fig. 219.—*Spirifer Niagarensis* (Conrad).

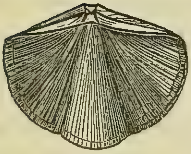


Fig. 220.—*S. radiatus* (Sowerby).

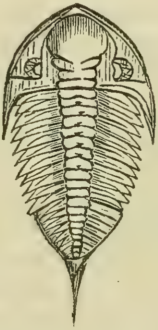


Fig. 221.—*Dalmannites limulurus* (Green).

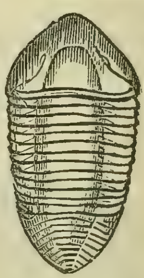


Fig. 222.—*Homalonotus delphinocephalus* (Green).

In addition to the above forms, *Strophomena rhomboidalis* (fig. 232), *Atrypa reticularis* (fig. 240), *Calymene Blumenbachii* (fig. 209), with various other species, are likewise more or less abundant. Some of the beds of this formation consist in great part also, of broken stems and other fragmentary remains of crinoids.

The Niagara formation (No. 11 in the sketch map, fig. 249) is well displayed around the great Falls and along the gorge of the Niagara River. The abrupt cliff-face or escarpment, which runs with slight interruption from that locality, to Cabot's Head on Georgian Bay, through portions of the Counties of Lincoln, Wentworth, Halton, Peel, Simcoe, and Grey, is made up principally of this series of strata. The formation constitutes also, Fitzroy Island, the "Flower Pots," &c., together with the southern portion of the Manitoulin Islands—from whence, turning to the south west, it extends along the western shore of Lake Michigan. Good exposures occur more particularly at the

Falls, and along the Niagara River between these and Queenston; also on the Welland Canal near Thorold; in the vicinities of Hamilton, Ancaster, Dundas, and Rockwood; at Belfontaine on the River Credit in the Township of Caledon; at various points in Mono, Mulmur, Nottawasaga, Artemisia, and Euphrasia Townships, where it forms high cliffs, more especially at the Nottawa and Beaver Rivers; Owen Sound and neighbourhood; Cape Paulet on Georgian Bay, and along the coast to Cape Chin; and likewise at Cabot's Head. At this latter locality, the lower part of the cliff, to a height of about 180 feet, consists of the Clinton subdivision—the Niagara beds resting upon this up to the summit of the promontory.

The annexed figure exhibits the Niagara and underlying strata as occurring in the gorge of the Niagara River between the Falls (*F*) and Queenston (*Q*). The dip of the beds, however, is unavoidably somewhat exaggerated.

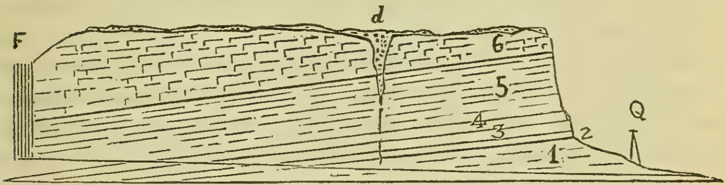


Fig. 223.—Section of the Niagara, Clinton, and Medina strata in the gorge of the Niagara River, between the Falls and Queenston.

1 = Red marls and shales (Medina).
2 = " Grey Band" (Medina).
3= Greenish shales (Clinton).
4 = Layer of Pentamerus limestone (Old Clinton; now referred to the Niagara Group).
5 = Calcareous shales (Niagara).
6 = Niagara limestone.
d, Drift and Post-Tertiary accumulations.

In the accompanying sketch, fig. 224, a section of the rocks across the Falls is shewn, with Goat Island (*G*) in the centre. No. 5, as in the preceding sketch, indicates the Niagara shales; No. 6, the thick bedded limestone; and *d* the Drift and Post-tertiary deposits. *A* denotes the American side, and *C* the Canadian shore. The Post-tertiary accumulations will be alluded to more fully in our description of

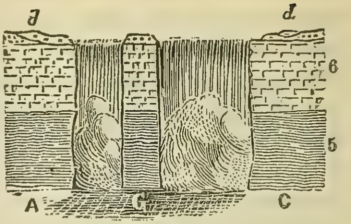


Fig. 224.

the Drift and succeeding deposits; but it may be observed that the more recent of these accumulations contain shells of the *unio, cyclas, melania,* and other fresh-water types now inhabiting the river, and evidently indicate, as first pointed out by Sir Charles Lyell and Professor James Hall of Albany, an ancient and at one time continuous deposit spread over the original river-bed. Accumulations of a similar character occur, however, in various parts of the Western Province, and were produced by our lake waters when these were united into one vast fresh-water sea, as explained in a subsequent part of this Essay.*

The limestones of the Niagara Formation yield excellent building materials, and quarries have been opened in these beds at Rockwood, Owen Sound, and other places.

In Eastern Canada, the Niagara strata, or rocks of the same geological horizon, are thought to occur in Gaspé, on the Chatte, Rimouski, and other rivers, and on Lake Metapedia; but much uncertainty still prevails with regard to the true position of these beds. They form the lower portion of the strata provisionally known as the "Gaspé limestones." In the Island of Anticosti in the Gulf of the St. Lawrence, however, there is a great display of limestone rocks undoubtedly of Middle Silurian age: the equivalents consequently of the Medina and Clinton, combined with the Niagara Formation. Along the more northern shore of the island, there runs a belt of Hudson River strata, as explained in our remarks under that formation; and this is succeeded by the limestones in question. These, with a few interstratified shales, occupy all the rest of the island, and make up, according to Mr. Richardson of the Geological Survey, a thickness of nearly 1,400 feet. The numerous fossils which they contain, have on the whole an essentially Upper Silurian character, but certain forms amongst them appear to establish a connecting link or passage between the Lower and Upper subdivisions of the Silurian series as originally recognised: hence the separation of the so-called Middle Silurian series—these Anticosti beds being taken as the type of the latter subdivision. The expediency of the separation, however, is somewhat questionable.

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* See a paper by the writer, on the ancient extension of our lake area, &c., in the *Philosophical Magazine* for July, 1861, and in the *Canadian Journal,* Vol. VI., p. 221. Also an article by Robert Bell, of the Canadian Geological Survey, in the *Canadian Naturalist* Vol. VI.

Finally, with regard to the Niagara Formation, it may be observed that limestone strata of apparently the same age, but resting on Huronian rocks, have been discovered at Lake Temiscamang, north of the great Laurentian water-shed which separates the northern geological area of Canada from the western and eastern areas of the south. See the general sketch of the distribution of our rock formations, a few pages further on.

The Guelph Formation:—The rocks of this formation, unlike the Niagara and other Canadian strata, have not been traced beyond the limits of the Province. The "Leclaire limestone" of Iowa, which at one time was thought to belong to the same geological horizon, is now referred by Professor Hall to the Niagara subdivision. The Guelph Formation, as known in Canada, follows the more western limit of the Niagara area, and occurs especially in the vicinities of Galt and Guelph. According to Sir William Logan, it appears to form a lenticular-shaped mass, gradually thinning out both westward in Lake Huron, and in the neighbourhood of Ancaster, in the east. Its greatest thickness is estimated at about 160 feet. Its strata consist essentially of white or light-coloured dolomites mostly of a peculiar semi-crystalline or granular texture. These yield excellent building materials.

Many of the enclosed fossils are identical with those of the Niagara beds, as *Favosites Gothlandica* (fig. 215), *Halysites catenulatus* (fig. 216), &c., but others appear to be confined to this formation.

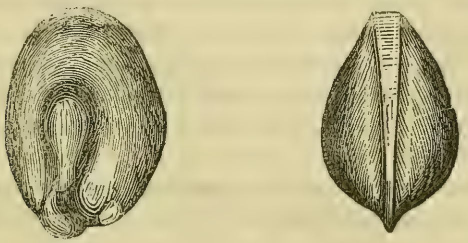

Fig. 225.—Casts of *Megalomus Canadensis* (Hall).

Amongst these, the most characteristic is the *Megalomus Canadensis*, usually found in the form of internal casts, as shewn in fig. 224.*

As a general rule, the fossils in these beds are somewhat obscure, and not very abundant. The principal exposures of the formation occur on the River Speed in the vicinity of Guelph ; at Elora, on the Irwine and Grand River, where it presents vertical cliffs over eighty feet in height ; at Hespeler on a branch of the Great Western Railway, ; and lower down the Grand River, at Preston, Galt, and places in the township of Dumfries. At present, the Guelph formation can only be regarded as a provisional group, its strata appearing more or less to merge into the underlying Niagara beds, and in some localities, also, to offer a passage into the Onondaga deposits.

(To be Continued.)

ON THE TWO SPECIES OF ASTACUS FOUND IN UPPER CANADA.

BY T. J. COTTLE, ESQ.

Read before the Canadian Institute, April, 1863.

Of the fresh water *Lobsters* as restricted by M. Milne Edwards to the genus Astacus, that learned historian of the Crustacea, in his valuable monograph enumerates but five. Of these he gives one to Europe, two to the North East side of America, one to Chili, and one to Australia : since his book was published one has been added to the North West of this continent, under the name of Oreganus ; and it is my intention to bring before the consideration of the Canadian Institute another, which I think, will form a new species indigenous to this Province, and which I propose naming (fodiens) as being appropriate to its habits. It is possible that it may have been already described, for the want of a good library of reference is a great impediment to the discrimination of species. I therefore feel a degree of diffidence in naming it.

The species described in the Natural History of the State of New York, as the only one belonging to it, is the Astacus Bartonii, and I shall merely copy the description given in that book, as it is too well known to require further notice.

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* This fossil is described in PART IV. as occurring in the Onondaga Group, the Guelph strata having been originally referred to that subdivision.

Astacus Bartonii, body with scattered punctures, rostrum mucronate concave elongated, suddenly attenuated, but with lateral angles rather than spines at the point of attenuation, no spines on the thorax; an acute triangular spine rather exceeding the rostrum in length articulated to the outer side of the base of the external antennæ, below the base of the spine on each side an oculiform tubercle, movable finger slightly shorter than its opposite, and a number of faveolæ or pits in such a regular series on both, as to produce the appearance of one or more elevated lines. Carpus with a deep furrow on its upper surface and one or more spines on its inner angle; shield with a transverse lunate furrow. The first segment of the middle caudal lamella, with one or two short spines on each side. Colour of the body and claws, greenish brown, tips of the rostrum of the hands and feet (and sexual appendices of the male) reddish; lighter beneath.

The other Canadian species, supposed to be undescribed may be thus characterised:—

Astacus fodiens (mihi) rostrum broad, short, triangular, acute, margined, concave throughout its length, edges smooth without spines. Carapace robust, rounded, much deeper than in Astacus Bartonii, plentifully marked with minute pits, granulated towards the stomachic region, not spinous. Claw stronger than in the preceding species, the movable finger with a strong tooth on the internal margin, external margin deeply denticulated, a well defined ridge along the whole length. Thumb with the internal margin less strongly toothed, smooth externally. Carpus with a strong spine on its inner margin and a deep furrow on its upper side, length 3 to 4 inches. Swamps and wet places common.

The author of the Natural History of the State of New York, and M. Edwards, both described an Astacus under the name of *affinis*, the former giving the habitat as the River Delaware, the latter as the rivulets of North America. Their two descriptions do not agree. In the first I see no resemblance to my Astacus, in the second a great deal: so much so, that I think we may, perhaps, both mean the same animal. M. Edwards gives, as his authority, Say's Crustacea of the United States, a work I have not been able to consult, but with which I should imagine the American author must be familiar. I shall quote both these descriptions that the members may compare them.

Astacus affinis of the New York work:—

Rostrum mucronate subcaniculate two spined, a spine behind each eye and a larger geminate one each side of the thorax, hand and thumb on the inner side, scabrous, length 3 by 3—River Delaware.

Astacus affinis of M. Milne Edwards. Rostrum short, nearly as broad as long, triangular and slightly toothed laterally. Carapace a little granular on the side of the stomachal region. Interior claws strong, carpus with a deep depression above, a large tooth within, and some tubercles below, hand rounded below; punctuated and tuberculated near the upper border. Fingers rather long and strong. Epistome short, widened without contraction or traverse groove, length 3 or 4 inches, inhabits rivers of North America.

The Astacus fodiens, is the first macrourous crustacean in which I have observed a burrowing habit, nor am I aware that this trait has been noticed by others. It is by no means unusual in some of the brachyura as in the genera Ocypoda, Cardisoma, &c., individuals of which so throng the sandy beaches and littoral marshes of the Antilles, but these crabs have strong legs, with the last joints armed with a hard sharp point well adapted for running and digging in the yielding sand. But not so with the delicate cheliferous legs of the slow-moving crawfish, which seem hardly able to bear its weight, apparently little fitted for tunneling its way through mud and clay: nevertheless, such is its destiny, for when the summer droughts have licked up the water on the surface of the swamps, where on the first arrival of spring this little crawfish had sported, it commences to seek by boring for the moisture of which it is deprived, and like an experienced well-digger, begins its work. The diameter of the hole is about an inch, and as it brings up the earth in its excavation t piles up the pellets round the circumference, till it forms a chimney the height of three or four inches. Should an explorer trace these holes downward, he will invariably find them terminating in water. In these burrows the animal lives during the whole of the dry season, deepening its hole as the receding water renders necessary during the night, as the freshly excavated wet earth lying round the entrance early in the morning testifies. I have never yet taken this species in streams or the Astacus Bartonii in swamps. I am unaware at what season of the year the intercourse between the sexes takes place, but I have found the eggs on the egg bearers in November, where they are carried during the whole winter and are hatched at the end of March or the beginning of

April. The young are then perfectly formed in every respect like the adults and undergo no metamorphosis, they remain attached to the parent till their first moult, which in some I kept in confinement did not take place till late in May, but I think it probably would have been earlier in a state of nature. The subject of the metamorphosis of the crustacea is one of great interest, and as yet of much uncertainty, though since the startling discovery ot Thompson much has been done ; yet how can we account for it, that some crustaceans as the genus now under consideration are hatched perfect, while according to M. Coste, the young of the nearly allied Palinuri constitute the old genus Phylopoma, and some have even asserted that the still more closely allied Homanus undergo change?

I was much surprised at the length of time required for incubation, being a fact I had not been aware of, but I find on the authority of M. Coste, that this habit is quite normal. He says "All the crustacea carry their eggs under their tail or some other part of the body where incubation takes place, this incubation is very generally slow, it does not take less than five or six months in Lobsters and Palinuri."

LIST OF PLANTS COLLECTED CHIEFLY IN THE IMMEDIATE NEIGHBOURHOOD OF LONDON, C. W.

BY W. SAUNDERS

A grateful acknowledgment is due Professor Hincks of University College, Toronto, for his unvarying kindness to the collector in determining a large number of the plants in the following list which, for want of time could not be named, while in a fresh condition. The Professor, from his extensive knowledge of the Flora of our country, has been enabled to determine with certainty from the dried specimens nearly all that have been submitted to him. There are, however, a few rare and interesting ones, which had not previously come under his observation, and which could not well be *positively* determined without fresh specimens. These will be found questioned, although in nearly every place the evidence furnished by the dry plant has been almost positive as to the entire correctness of the name given.

The mosses and lichens have been determined, chiefly from a collection kindly furnished by B. Billings, Jr., Esq., of Prescott, C. W.

It will be observed that several of the families are but poorly represented; for example, Salicaceæ, Cyperaceæ and Gramineæ. In these, and several of the others, much remains to be done to complete the list of our Western Canadian flora.

RANUNCULACEÆ.

Clematis Virginiana, L.; bank of Cove, one mile west of London; rare.
Anemone Virginiana, L.; common.
" Pennsylvanica, L.; common.
" nemorosa, L.; English's Woods; abundant.
Hepatica triloba, Chaix.; common.
" acutiloba, D.C.; not very common.
Thalictrum dioicum, L.; common.
" cornuti, L.; common.
Ranunculus aquatilis, L. var. divaricatus; very abundant at Cove.
" Purshii, Richards; in pond half a mile west of London.
" rhomboideus, Goldie; sandy fields; common.
" abortivus, L.; common.
" recurvatus, Poir.; banks of Cove; not common.
" Pennsylvanicus, L.; St. Catharines, C. W.
" fascicularis, Muhl.; common on G. W. R. R. track east of London.
" repens, L.; wet places; common.
Caltha palustrus, L.; abundant.
Coptis trifolia, Salisbury; English's Woods and elsewhere; common.
Aquilegia Canadensis, L.; common.
Hydrastis Canadensis, L.; Township of Williams, C. W.; common.
Actæa spicata, L. var. alba; common.
" " rubra; common.

MAGNOLIACEÆ.

Liriodendron tulipifera, L.; St. Catharines, C. W.

MENISPERMACEÆ.

Menispermum Canadense, L.; moist woods two miles north of London.

BERBERIDACEÆ.

Caulophyllum thalictroides, Michx.; rich woods; common.
Jeffersonia diphylla, Pers.; on banks of river, near Cove; common.
Podophyllum peltatum, L.; very common.

NYMPHACEÆ.

Nymphaea odorata, Ait.; abundant in Westminster pond, three miles south of London.

Nuphar advena, Ait.; common at Cove.

SARRACENIACEÆ.

Sarracenia purpurea, L.; border of Westminster pond; common.

PAPAVERACEÆ.

Chelidonium majus, L.; not uncommon.

Sanguinaria Canadensis, L.; rich woods; common.

FUMARIACEÆ.

Dicentra cucullaria, D.C.; wooded banks of Cove; common.

“ Canadensis, D.C.; banks of Cove; common.

CRUCIFERÆ.

Nasturtium officinale, R. Br.; in creek half a mile west of London; abundant.

“ palustre, D.C.; vicinity of Cove; abundant.

“ armoracia, Fries.; not uncommon.

Iodanthus hesperidoides, Torr. and Gray; rare.

Dentaria diphylla, L.; English's woods; common.

“ laciniata, Muhl.; banks of Cove; common.

Cardamine rhomboidea, D.C.; wet places; common.

“ “ var. purpurea, Torr.; borders of Cove; not uncommon.

“ hirsuta, L.; common.

Arabis lyrata, L.; not common.

“ hirsuta, Scop.; bank of river, near Cove; common.

“ lævigata, D.C.; not uncommon.

Erysimum cheiranthoides, L.; rare.

Sisymbrium officinale, Scop.; in waste places everywhere; common.

Sinapis arvensis, L.; G. W. R. R. track, near Cove; common.

Lepidium Virginicum, L.: G. W. R. R. track, east of London; abundant.

Capsella bursa-pastoris, Mœnch.; everywhere; common.

VIOLACEÆ.

Viola blanda, Willd.; common.

“ cucullata, Ait.; common.

“ villosa, Walt, Nutt.; cemetery and open fields near English's woods; not very common.

“ rostrata, Pursh.; English's woods and eleswere; common.

Viola Muhlenbergii, Torr.; rather rare.
" striata, Ait.; common.
" Canadensis, L.; common.
" pubescens, Ait.; common.

CISTACEÆ.

Helianthemum Canadense, Michx.; English's woods; common.
Lechea major, Michx.; rare.
" minor, Lam.; not very common.

DROSERACEÆ.

Drosera rotundifolia, L.; borders of Westminster pond; common.
" longifolia, L.; Westminster pond; common.

PARNASSIACEÆ.

Parnassia Caroliniana, Michx.; Port Stanley R. R. track; not common.

HYPERICACEÆ.

Hypericum pyramidatum, Ait.; Port Stanley R. R. track, two miles from London; not common.
" perforatum, L.; common.
" corymbosum, Muhl.; common.
" ellipticum, Hook.; rare.
" mutilum, L.; common.

CARYOPHYLLACEÆ.

Saponaria officinalis, L.; G. W. R. R. track, one mile east; common.
Agrostemma Githago, L.; common.
Alsine Michauxii, Fenzle; G. W. R. R. track, one mile east; very common.
Arenaria serpyllifolia, L.; common.
Stellaria media, Smith; everywhere; common.
" longifolia, Muhl.; common.

PORTULACACEÆ.

Portulaca oleracea, L.; waste grounds; abundant.
Claytonia Virginica, L.; banks of Cove; abundant.

MALVACEÆ.

Malva rotundifolia, L.; common.
" moschata, L.; roadsides; not common.

TILIACEÆ.

Tilia Americana, L.; common.

OXALIDACEÆ.

Oxalis stricta, L.; common.

Geraniaceæ.

Geranium maculatum, L.; common.
" Robertianum, L.; woods near Cove; common.

Balsaminaceæ.

Impatiens fulva, Nutt.; common.

Rutaceæ.

Zanthoxylum Americanum, Mill.; half a mile west of London; not uncommon.

Aancacardiaceæ.

Rhus typhina, L.; common.
" glabra, L.; common.
" Toxicodendron, L.; common.

Vitaceæ.

Vitis cordifolia, var. riparia, Michx.; common.
Ampelopsis quinquefolia, Michx.; common.

Rhamnaceæ.

Rhamnus alnifolius, L'Her.; common in swampy places.
Ceanothus Americanus, L.; very abundant in cemetery.

Celastraceæ.

Celastrus scandens, L.; woods, five miles north of London; not uncommon.
Enonymus Americanus, L.: English's woods; common.

Sapindaceæ.

Staphylea trifolia, L.; wooded bank half a mile west of London; common.
Acer spicatum, Lam.; not common.
" saccharinum, Wang.; common.
" rubrum, L.; common.

Polygalaceæ.

Polygala Senega, L.; G. W. R. R. track east, and cemetery; not uncommon.
" polygama, Walt.; sandy field near English's woods; rare.

Leguminosæ.

Lupinus perennis, L.; cemetery and G. W. R. R. track east; very common.
Trifolium pratense, L.; common.
" repens, L.; common.
Astragalus Canadensis, L.; G. W. R. R. track near Cove; common.

Desmodium acuminatum, D.C.; common.
" paniculatum, D.C.; rare.
Lespedeza capitata, Michx.; G.W.R.R. track; common.
Vicia Caroliniana, Walt.; rare.
Phaseolus helvolus, L.; G. W. R. R. track one mile east; not common.
Apios tuberosa, Mœnch; Port Stanley R. R. track two miles from London.

Rosaceæ.

Prunus Pennsylvanica, L.; common.
" Virginiana, L.; common.
" serotina, Erhart; not uncommon.
Spirea opulifolia, L.; rather rare.
" salicifolia, L.; common.
Agrimonia parviflora, Ait.; common.
Geum album, Gmelin; common.
" strictum, Ait.; common.
" rivale, L.; common.
" triflorum, Pursh; abundant in cemetery.
Waldsteinia fragarioides, Tratt.; common.
Potentilla norvegica, L.; common.
" canadensis, L.; G. W. R. R. track, and elsewhere; common.
" anserina, L.; common.
" palustris, Scop.; Westminster pond; common.
Fragaria vesca, L.; common.
Rubus triflorus, Richardson; common.
" strigosus, Michx.; common.
" villosus, Ait.; common.
" hispidus, L.; common in swamps.
Rosa Carolina, L.; G. W. R. R. track near Komoka, twelve miles from London.
" blanda, Ait.; common.
Cratœgus coccinea, L.; common.
" tomentosa, L.; not uncommon.
" " var. punctata, Jacq.; rather rare.
" crusgalli, L.; common.
Pyrus coronaria, L.; common.
" arbutifolia, L.; common.
Amelanchier Canadensis, Torr. and Grey; moist places; very common.

ONAGRACEÆ.

Epilobium angustifolium, L.; G. W. R. R. track east, and elsewhere; common.
" palustre, L.; common.
" coloratum, Muhl.; common in wet places.
Œnothera biennis, L.; common.
" " " var. cruciata; common.
Ludivigia palustris, Ell.; very common.
Circaea alpina, L.; not common.

GROSSULACEÆ.

Ribes cynosbati, L.; common.
" hirtellum, Michx.; common.
" lacustre, Poir.; common in swamps.
" floridum, L.; very common.
" rubrum, L.; common.

CRASSULACEÆ.

Penthorum sedoides, L.; wet places; common.

SAXIFRAGACEÆ

Saxifraga Virginiensis, Michx.; common.
Mitella diphylla, L.; English's woods, and elsewhere; very common.
" nuda, L.; English's woods; rare.
Tiarella cordifolia, L.; common.
Chrysosplenium Americanum, Schwein; English's swamp; common.

HAMAMELACEÆ.

Hamamelis Virginica, L.; common.

UMBELLIFERÆ.

Sanicula Canadensis, L.; rich woods; common.
" Marylandica, L.; not very common.
Heracleum lanatum, Michx.; not uncommon.
Archangelica peregrina? Nutt.; rare.
Thaspium barbinode, Nutt.; rare.
" aureum, Nutt.; common.
Zizia integerrima, D.C.; common.
Cicuta maculata, L.; wet places; common.
Sium lineare, Michx.; swamps; common.
Cryptotænia Canadensis, D.C.; rare.
Osmorrhiza longistylis, D.C.; rich woods; common.
" brevistylis, D.C.; rich woods; common.

Conium maculatum, L.; very abundant in lower part of city, near river.
Erigenia bulbosa, Nutt.; this very interesting and beautiful little plant is very common with us on the borders of rich woods.

ARALIACEÆ.

Aralia racemosa, L.; not uncommon in rich moist woods.
" nudicaulis, Michx.; English's woods, and elsewhere; common.
" triflora, L.; English's woods; abundant.
" quinquefolia, L.; four miles north of London; rare.

CORNACEÆ.

Cornus Canadensis, L.; rich woods; not common.
" stolonifera, Michx.; common.
" paniculata, L'Her.; not uncommon.

CAPRIFOLIACEÆ.

Lonicera parviflora, Lam.; common.
" ciliata, Muhl.; common in damp woods.
Diervilla trifida, Mœnch.; not uncommon.
Triosteum perfoliatum, L.; common.
Sambucus Canadensis, L.; common.
" pubens, Michx.; common.
Viburnum Lentago, L.; common.
" dentatum, L.; common.
" acerifolium, L.; rather rare.
" opulus, L.; common.

RUBIACEÆ.

Galium asprellum, Michx.; common.
" trifidum, L.; common in wet places.
" triflorum, Michx.; common in rich woods.
" lanceolatum, Torr.; rare.
" boreale, L.; very common.
Mitchella repens, L.; rich woods; common.

COMPOSITÆ.

Liatris cylindracea, Michx.; common in cemetery.
" spicata, Willd.; vicinity of Cove; very rare; abundant near Amerstburg, C.W.
Eupatorium purpureum, L.; common.
" perfoliatum, L.; very common.
" ageratoides, L.; not common.
Aster laevis, var. cyaneus, L.; not common.

Aster azureus, Lindl.; G. W. R. R. track; not common.
" cordifolius, L.; common.
" saggittifolius, Willd.; common.
" Tradescanti, L.; common.
" miser, L.? rare.
" simplex, Willd.; G. W. R. R. track, and elsewhere; common.
" carneus, Nees.; not common.
" longifolius, Lam.; moist woods; not common.
" puniceus, L.; common.
" Novæ-Angliæ, L.; not common.
" nemoralis, Ait.; rare.
Erigeron Canadensis, L.; very common.
" bellidifolius, Muhl.; not common.
" Philadelphicus, L.; common.
" annuus, Pers.; common.
" strigosus, Muhl.; rare.
Solidago latifolia, L.; rich woods; common.
" cæsia, L.; common at Cove.
" puberula, Nutt.
" altissima, L.; very common.
" pilosa, Walt.? rare.
" nemoralis, Ait.; not common.
Inual Helenium, L.; Peters' swamp one mile west of London; common.
Ambrosia artemesiaefolia, L.; G. W. R. R. track east; abundant.
Rudbeckia subtomentosa, Pursh.? moist places, Port Stanley R. R. track, two miles from London.
" fulgida, Ait.; G. W. R. R. track; not uncommon.
" hirta, L.; G. W. R. R. track; abundant.
Helianthus giganteus, L.; not uncommon.
" strumosus, L.; rare.
" decapetalus, L.; very common.
Bidens frondosa, L.; not uncommon.
" cernua, L.; common in wet places.
" chrysanthemoides, Michx.; common in wet places.
Maruta cotula, D.C.; very common in waste places.
Achillea Millefolium, L.; abundant.
Tanacetum vulgare, L.; common.
Artemisia biennis, Willd.; common in waste places.
Gnaphalium polycephalum, L.; common; English's woods, and elsewhere.

Gnaphalium uliginosum, L.; rare.
Antennaria margaritacea, R. Brown; rare.
" plantaginifolia, Hook.; common.
Erecthites hieracifolia, Raf.; moist grounds; not uncommon.
Senecio aureus, L.; common in wet places.
Cirsium lanceolatum, Scop.; very abundant.
" discolor, Spreng.; English's woods; not uncommon.
" muticum, Michx.; swamp, two miles north of London.
" arvense, Scop.; common.
Lappa major, Gærtn.; very abundant.
Cichorium Intybus, L.; rare.
Hieracium scabrum, Michx.; not uncommon.
" Gronovii, L.; rare.
Nabalus albus, Hook.; G. W. R. R. track east; common.
" altissimus, Hook.; English's woods; common.
Taraxacum Dens-leonis, Desf.; everywhere common.
Lactuca elongata, Muhl.; Port Stanley R. R. track; common.
Sonchus asper, Vill.; banks of Cove; common.

LOBELIACEÆ.

Lobelia cardinalis, L.; wet ground; common.
" syphilitica, L.; common.
" inflata, L.; not uncommon.
" spicata, Lam.; G. W. R. R. track east; common.
" Nuttallii, Roem. and Sch.; banks of river Thames, near London; rare.

CAMPANULACEÆ.

Campanula rotundifolia, L.; banks of Thames, near Komoka, twelve miles from London; common.
" aparinoides, Pursh.; wet places; common.
" Americana, L.; rich woods; rare.

ERICACEÆ.

Vaccinium macrocarpum, Ait.; borders of Westminster pond; common.
" Pennsylvanicum, Lam.; common.
Chiogenes hispidula, Torr. and Gray.; boggy places; common.
Gaultheria procumbens, L.; common.
Cassandra calyculata, Don.; borders of Westminster pond; common.
Andromeda polifolia, L.; border of Westminster pond; common.
Kalmia glauca, Ait.; border of Westminster pond; common.

Pyrola elliptica, Nutt.; rich woods; not uncommon.
" secunda, L.; common.
Moneses uniflora, L.; under clumps of pines in English's woods.
Chimaphila umbellata, Nutt.; under pines in English's woods.
Monotropa uniflora, L.; woods near Westminster pond; common.

PLANTAGINACEÆ.

Plantago major, L.; common everywhere.
" lanceolata, L.; Port Stanley R. R. track, three miles from London; common.

PRIMALUCEÆ.

Trientalis Americana, Pursh.; English's swamp; common.
Lysimachia stricta, Ait.; rare.
" ciliata, L.; wet places; common.
Naumbergia thyrsiflora, Reichenb; Cove; common.

LENTIBULACEÆ.

Utricularia vulgaris, L.; stream on sides of G. W. R. R. track, half a mile west.
" cornuta, Michx.; banks of Westminster pond; abundant.

OROBANCHACEÆ.

Epiphegus Virginiana, Bart.; English's woods; common.
Conopholis Americana, Wallroth; woods near Westminster pond; rare.

SCROPHULARIACÆ.

Verbascum Thapsus, L.; everywhere common.
Linaria vulgaris, Mill.; common in waste places.
Scrophularia nodosa, L.; field near Cove; not common.
Chelone glabra, L.; swampy places; common.
Mimulus ringens, L.; wet places; common.
Veronica Americana, Schweinitz; common.
" serpyllifolia, L.; very common.
Gerardia quercifolia, Pursh.; Wesleyan cemetery and G. W. R. R. track; common.
Castilleia coccinea, Spreng.; G. W. R. R. track east; common.
Pedicularis Canadensis, L.: English's woods; abundant.

VETBENACEÆ.

Verbena hastata, L.; common in waste places.
" urticifolia, L.; not uncommon.

LABIATÆ.

Teucrium Canadense, L.; not common.

Mentha viridis, L.; common.
" piperita, L.; common.
" Canadensis, L.; common.
Lycopus Virginicus, L.; common.
" Europæus, L.; rare.
" " var. sinuatus, L.; rare.
Calamintha Clinopodium, Benth.
Hedeoma pulegioides, Pers.; common ten miles west of London.
Collinsonia Canadensis, L.; border of a field, two miles west of London.
Monarda didyma, L.; common.
" fistulosa, L.; half a mile west of London; common.
Lophanthus nepetoides, Benth.; fields near Cove; not uncommon.
Nepeta cataria, L.; common.
Prunella vulgaris, L.; common.
Scuttellaria integrifolia, L.; moist thickets; common.
" galericulata, L.; Port Stanley R. R. track, moist places; common.
" lateriflora, L.; borders of English's creek; not uncommon.
Marrubium vulgare, L.; common.
Galeopsis tetrahit, L.; rare.
Stachys palustris, L.; not uncommon.
Leonurus cardiaca, L.; common.

BORRAGINACEÆ.

Echium vulgare, L.; banks of river Thames; common.
Symphytum officinale, L.; not uncommon.
Onosmodium Carolinianum, D.C.; not uncommon.
Lithospermum officinale, L.; common.
" hirtum, Lehm.?; rare.
" canescens, Lehm.; rare.
Mysotis palustris, With.; wet places; common.
" " var. laxa, Lehm.; wet places; common.
" verna, Nutt.; rare.
Cynoglossum officinale, L.; common everywhere.
" Virginicum, L.; rare.
" Morrisoni, D.C.; G. W. R. R. track east; very abundant.

HYDROPHYLLACEÆ.

Hydrophyllum Virginicum, L.; banks of Cove; common.
" Canadense, L.; Cove; not common.
" appendiculatum, Michx.; Cove and elsewhere; common.

POLEMONIACEÆ.

Phlox divaricata, L.; English's woods and elsewhere; very common.

CONVOLVULACEÆ.

Calystegia spithamæa, Pursh.; G. W. R. R. track; common.

SOLANACEÆ.

Solanum nigrum, L.; common.
Physalis viscosa, L.; G. W. R. R. track east; common.
Datura stramonium, L.; waste places; common.

GENTIANACEÆ.

Halenia deflexa, Griseb.; rare.
Gentiana quinqueflora, Lam.; Wesleyan cemetery; common.
" crinita, Fræl.; moist woods two miles north-east of London; common.
" Andrewsii, Griseb.; borders of English's creek; not common.
Menyanthes trifoliata, L.; borders of Westminster pond and elsewhere; abundant.

APOCYNACEÆ.

Apocynum androsæmifolium, L.; G. W. R. R. track; abundant.

ASCLEPIADACEÆ.

Asclepias cornuti, Decaisne, waste places; common.
" phytolaccoides, Pursh.; Port Stanley R. R. track; common.
" incarnata, L.; Port Stanley R. R. track; common.
" tuberosa, L.; G. W. R. R. track east; common.

OLEACEÆ.

Fraxinus Americana, L.; common.
" sambucifolia, Lam.; common.

ARISTOLOCHIACEÆ.

Asarum Canadense, L.; common.

PHYTOLACCACEÆ.

Phytolacca decandra, L.; Port Stanley R. R. track; not uncommon.

CHENOPODIACEÆ.

Chenopodium hybridum, L.; common.
" album, L.; a troublesome weed.
" botrys, L.; waste places; not uncommon.
" ambrosioides, L.; rare.

AMARANTACEÆ.

Amaranthus albus, L.; a troublesome weed.

Montelia tamariscina, Nutt.; sandy flats near river Thames; not uncommon.

POLYGONACEÆ.

Polygonum amphibium, L.; Cove; not uncommon.
" nodosum, var. incarnatum, Pers.; not uncommon.
" Pennsylvanicum, L.; common.
" persicaria, L.; common.
" acre, H.B.K.; English's creek; common.
" aviculare, L.; common everywhere.
" " var. erectum, Roth.; common.
" Virginianum, ? L.; creek three miles north of London.
" dumetorum, L.; borders of creek half a mile west of London.

Fagopyrum esculentum, Mœnch.; common.
Rumex verticillatus, L.; moist grounds, common.
" crispus, L.; everywhere common.
" sanguineus, L.; Port Stanley R. R. track two miles from London.

LAURACEÆ.

Benzoin odoriferum, Nees.; English's woods and elsewhere common.

THYMELACEÆ.

Dirca palustris, L.; common.

SANTALACEÆ.

Comandra umbellata, Nutt.; G. W. R. R. track east, common.

EUPHORBIACEÆ.

Euphorbia obtusata, Pursh.; St. Catherines roadsides, common.
Acalypha Virginica, L.; Cove; common.

URTICACEÆ.

Ulmus fulva, Michx.; common.
Urtica, gracilis, Ait.; common.
" dioica, L.; very common.
" purpurescens, Nutt.; rare.
Laportea Canadensis, Gaudich.; not uncommon.
Pilea pumila, Lindl.; common in wet places.
Bœhmeria cylindrica, Wild.; rich woods, three miles north-east of London; rare.
" lateriflora, Muhl.; rare.
Cannabis sativa, L.; common.

PLATANACEÆ.

Platanus occidentalis, L.; banks of river Thames; common.

JUGLANDACEÆ.

Juglans cinerea, L.; borders of Cove; common.
" nigra, L.; two miles west of London; not uncommon.
Carya alba, Nutt.; two miles north east of London; not common.

CUPULIFERÆ.

Quercus alba, L.; common.
Castanea vesca, L.; Hall's mills, seven miles from London; abundant.
Fagus ferruginea, Ait.; common.
Corylus Americana, Walt.; common.
Carpinus Americana, Michx.; common.
Ostrya Virginica, Willd.; not uncommon.

BETULACEÆ.

Betula excelsa, Ait.; not uncommon.

SALICACEÆ.

Salix discolor, Muhl.; not uncommon.
" sericea, Marshall.; common.
" rostrata, Richardson; common.
Populus tremuloides, Michx.; common.
" grandidentata, Michx.; not common.
" balsamifera, L.; common.

CONIFERÆ.

Pinus strobus, L.; very abundant.
Abies Canadensis, Michx.; common.
Larix Americana, Michx.; common.
Thuya occidentalis, L.; common.

ARACEÆ.

Arum triphyllum, Torr.; moist grounds; common.
Calla palustris, L.; Westminister pond; not common.
Symplocarpus fœtidus, Salisb.; wet places; commmon.
Acorus calamus, L.; wet places; commonr

TYPHACEÆ.

Typha angustifolia, L.; Port Stanley R. R. track, banks of creek three miles from London; common.
Sparganium simplex, Hudson.; Port Stanley R. R. track, three miles from London; not common.

LEMNACEÆ.

Lemna minor, L.; small ponds half a mile west; common.

NAIADACEÆ.

Potamogeton natans, L.; Cove; common.

ALISMACEÆ.

Alisma plantago, L.; common.
Sagittaria variabilis, var. sagittifolia, Pursh.; Cove; common.

ORCHIDACEÆ.

Orchis spectabilis, L.; common.
Gymnadenia tridentata, Lindl.; rare.
Platanthera orbiculata, Lindl.; under clumps of pines in English's woods; not common.
" bracteata, Torr.; rare.
" dilatata, Lindl.: English's swamp; common.
" psycodes, Gray.; English's swamp; common.
Goodyera pubescens, R. Brown.; rich woods; common.
Spiranthes gracilis, Bigelow.; G. W. R. R. track east; common.
Pogonia ophioglossoides, Nutt.; borders of Westminster pond; common.
Calopogon pulchellus, R. Brown.; Westminster pond; common.
Cypripedium pubescens, Willd.; English's swamps and elsewhere; common.
" spectabile, Swartz.; Westminster pond; rare.
" acaule, Ait.; Westminister pond; not common.

IRIDACEÆ.

Iris versicolor, L.; common.
Sisyrinchium Bermudiana, L.; common.

SMILACEÆ.

Smilax herbacea, L.; common.
Trillium erectum, L.; common.
" grandiflorum, Salisb.; common.
Medeola Virginica, L.; English's woods; not uncommon.

LILIACEÆ.

Smilacina racemosa, Desf.; common.
" stellata, Desf.; English's woods; rare.
" bifolia, Ker.; common.
Clintonia borealis, Raf.; English's woods; common.

Allium tricoccum, Ait. ; English's woods ; not uncommon.
Lilium Philadelphicum, L. ; G. W. R. R. track east ; common.
" superbum, L.; moist grounds, half a mile west of London ; not uncommon.
Erythronium Americanum, Smith. ; very common.

MELANTHACEÆ.

Uvularia perfoliata, L. ; English's woods and elsewhere ; common.
Streptopus roseus, Michx. ; rich woods ; common.

JUNCACEÆ.

Luzula pilosa, Willd. ; rich woods ; common.
" campestris, D. C, ; open field near English's swamp ; common.
Juncus effusus, L. ; not uncommon.
" filiformis, L. ; not uncommon.
" tenuis, Willd. ; very common.
" bufonius, L. ; common.

CYPERACEÆ.

Cyperus diandrus, Torr. ; banks of a stream near St. Thomas, seventeen miles from London.
" strigosus, L. ; rare.
Eleocharis olivacea, Torr. ; rare.
" palustris, R. Brown. ; common.
" rostellata, ? Torr. ; not common.
" acicularis, R. Brown ; common.
Scirpus lacustris, L. ; common.
" sylvaticus, L. ; common.
Eriophoron Virginicum, L. ; borders of Westminister pond ; common.
" polystachyon, L. ; G. W. R. R. track, east ; not common.
" gracile, Koch. ; rare.
Carex bromoides, Schk. ; common.
" vulpina, L. ; common.
" Deweyana, Schw. ; rare.
" stellulata, Good. ; rare.
" gracillima, Schw. ; not common.
" præcox, Jacq. ; very common.
" hystricina, Willd. ; not uncommon.
" tentaculata, Muhl. ; G. W. R. R. track, half a mile west.
" lupulina, var. polystachya, Muhl. ; not uncommon.
" cylindrica, Schw. ; rare.

GRAMINEÆ.

Phleum pratense, L. ; very common.
Agrostis scabra, Willd. ; not common.
" alba, L. ; common everywhere.
Muhlenbergia Mexicana, Trin. ; common.
Glyceria fluitans, R. Brown ; common.
Poa pratensis, L. ; common.
Bromus Kalmü ; not uncommon.
Elymus Virginicus, L. ; not common.
Gymnostichum Hystrix, Schreb.
Milium effusum, L. ; common.
Panicum glabrum, L. ; Gaudin. ; Cemetery ; common.
" latifolium, L. ; not uncommon.
" dichotomum, L. ; common.
" crus-galli, L. ; common everywhere.
Setaria viridis, Beauv. ; abundant.
Andropogon argenteus, Ell. ; not common.

EQUISETACEÆ.

Equisetum arvense, L. ; moist grounds half a mile west of London ; common.
" limosum, L. ; G. W. R. R. track near Komoka, C. W. ; common.
" hyemale, L. ; G. W. R. R. track ; common.
" variegatum, Schleisher ; English's wooods ; not uncommon.

FILICES.

Polypodium hexagonopterum, Michx. ; rich woods near Westminster pond ; rather rare.
Struthiopteris Germanica, Willd. ; half a mile west of London ; common.
Pteris aquilina, L. ; common.
" " var. caudata, L. ; common.
Adiantum pedatum, L. ; common.
Asplenium thelypteroides, Michx. ; English's woods ; not uncommon.
" Filix-fœmina, R. Brown ; common.
Cystopteris bulbifera, Bernh. ; rich woods ; common.
" fragilis, Bernh. ; banks of Cove ; common.
Aspidium thelypteris, Swartz. ; not uncommon.
" noveboracense, Willd. ; not common.
" spinulosum, Swartz. ; rich woods ; very common.

Aspidium Goldianum, Hook.; not common.
" cristatum, Swartz.; English's woods, common.
" marginale, Swartz.; common.
" acrostichoides, Swartz.; rich woods; very common.
Onoclea sensibilis, L.; English's woods; common.
Osmunda regalis, L.; English's swamp; common.
" Claytoniana, L.; swamp near Komoka, C. W.; common.
" cinnamonea, L.; English's woods; very abundant.
Botrychium lunarioides, Swartz.; field near English's woods, and elsewhere; not common.
" " var. obliquum, Muhl.; Wesleyan cemetery; not common.
" Virginicum, Swartz.; English's woods and elsewhere; common.

LYCOPODIACEAE.

Lycopodium lucidulum, L. rich woods; common.
" dendroideum, Michx.; not common.
" clavatum, L.; not uncommon.
" complanatum, L.; English's woods; common.
Selaginella apus, Spreng.; rare. I much regret that the exact locality where this very interesting little plant was found, has been for the time lost. It was somewhere within two or three miles of London.

MUSCI.

Loucobryum glaucum, Hampe.; not common.
Atrichum undulatum, Beauv.; common.
Polytrichum juniperinum, Hedw.; very common.
Bryum roseum, Schreb.; English's woods; common.
Mnium affine, Bland.; common.
" cuspidatum, Hedw.; common.
Bartramia pomiformis, Hedw.
Leskea rostrata, Hedw.; common.
Hypnum triquetrum, L.; common.
" Schreberi, Willd.
" molluscum, Hedw.
" imponens, Hedw.
" salebrosum, Hoffm.
" acuminatum, Beauv.

HEPATICÆ.

Fegatella conica, Corda.; very common.
Mastigobryum trilobatum, Nees.; not uncommon.

LICHENES.

Usnea barbata, Fr.; from trees on borders of Westminister pond; not common.
" angulata, Ach.; same locality as last.
Sticta pulmonaria, Ach.; common.
Parmelia terebrata, Mart.
" caperata, Ach.
" hypoleuca, Muhl.
Cladonia rangiferina, Hoffm.
" Floerkiana, Fr.; very common on decaying stumps in English's woods.

MEAN METEOROLOGICAL RESULTS AT TORONTO FOR THE YEAR 1862.

BY G. T. KINGSTON, M.A.
DIRECTOR OF THE MAGNETICAL OBSERVATORY.

The mean temperature of the year 1862 differed very slightly from the average of 22 years, being only 0°.23 in excess. The monthly means likewise conformed in an unusual degree to their respective averages, the mean deviation without regard to sign being 1°.42 in 1862, while the average of these deviations in 22 years was 2°.45.

As regards the distribution of temperature through the year, the first seven months, with the exception of May, were relatively cold, being on the whole 0°.75 below the average, while the temperature of the remaining five months exceeded the average by 1°.60, and, with the exception of November, were all relatively warm. January and February, though comparatively cold, do not supply examples of very low temperatures, the minimum of the year, —5°.2 on February 15, being the highest minimum that has occurred since 1847, and 7°.0 warmer than the average of the yearly minima. Again, while July was relatively cold it furnishes the highest maximum, 95°.5, that has been recorded since 1856, when the temperature reached 96°.6.

The year was on the whole deficient in rain, the total fall being less than the average by 4.795 inches. The excess of snow, which may be taken as equal to 2.377 inches of rain, still leaves a deficiency of 2.418 inches from the average annual precipitation. The lack of rain that occurred in April, May, and June, was in some degree compensated by the abundant snow in January, February, and March, which exceeded by 75 per cent. the usual fall, and served to maintain below the surface an amount of moisture sufficient for the supply of the more deeply rooted plants, and to mitigate the ill effects that might have been apprehended from the drought of the three following months.

In the following summary several of the results of 1862 are compared with the averages derived from a series of years, as well as with extreme values of analogous results that have occurred during the same series.

TEMPERATURE.

	1862.	Average of 22 years.	Extremes in 22 years.	
Mean Temperature of the Year .	44°.35	44°.12	46°.36 (in 1846).	42°.16 (in 1856).
Warmest Month	August.	July.	July, 1854.	Aug. 1860.
When the mean temperature of the month was	67.60	66.85	72.47	64.46
Coldest Month	January.	February.	Jan. 1857.	Feb. 1848.
When the mean temperature of the month was	21.71	22.98	12.75	26.60
Difference between the warmest and coldest months.........	45.89	43.87	..	..
Mean of deviations of monthly means from their respective averages of 22 years, signs of deviation being disregarded.	1.42	2.44	3.55 (in 1843 and 1857).	1.35 (in 1853).
Month of greatest deviation, without regard to sign	October.	January.	Jan. 1857.	..
When the mean of the month differed from the 22 years' average for that month by .	3.2	3.9	10.7	..
Warmest Day................	August 8.	July 20.	July 12,'45.	July 31,'44.
When the mean of the day was	79.08	77.28	82.32	72.75

TEMPERATURE—(*Continued.*)

	1862.	Average of 22 years.	Extremes in 22 years.	
	°	°	°	°
Coldest Day	January 3.	Jan. 24.	Feb. 6, '55, Jan. 22, '57.	Dec. 22, '42.
When the mean of the day was	2.42	—0.87	—14.38	+9.57
Highest temperature	95.5	90.4	99.2	82.4
Which occurred on	July 6.	July 22.	Aug. 24,'54.	Aug. 19,'40.
Lowest temperature	—5.2	—12.2	—26.5	+1.9
Which occurred on	Feb. 15.	Jan. 25	Jan. 26, '59.	Jan. 2, '42.
Range of the year	100.7	102.6	118.2 (in 1855).	87.0 (in 1847).

BAROMETER.

	1862.	Average of 18 years.	Extremes in 18 years.	
Mean pressure of the year	29.6248	29.6133	29.6679 (in 1849).	29.5880 (in 1852).
Month of highest pressure	January.	September.	June, 1849.	Sept. 1860.
When the mean pressure for the month was	29.7274	29.6629	29.8030	29.6733
Month of lowest pressure	March.	June.	Mar. 1859.	Nov. 1849.
When the mean pressure for the month was	29.5036	29.5624	29.4215	29.5868

	1862.	Average of 9 years.	Extremes in 9 years.	
Maximum pressure of the year	30.469	30.372	30.552	30.245
Which occurred	Nov. 15, at 10 a.m.	..	Jan. 1855.	Dec. 1854.
Minimum pressure of the year	28.805	28.592	28.286	28.849
Which occurred	March 3, at 11 p.m.	..	Mar. 1859.	Mar. 1858.
Range of the year	1.664	1.780	2.106 (in 1859).	1.429 (in 1860).

HUMIDITY.

	1862.	Average of 20 years.	Extremes in 20 years.	
Mean humidity of the year	77	78	82 (in 1851).	73 (in 1858).
Month of greatest humidity	February.	January.	Jan. 1857.	Dec. 1858.
When the mean of the month was	84	83	89	81
Month of least humidity......	May.	May.	Feb. 1843.	April, 1849.
When the mean of the month was	65	72	58	76

CLOUDS.

	1862.	Average of 10 years.	Extremes in 10 years.	
Mean cloudiness of the year ...	63	60	63 (in 1862).	57 (in '53&56).
Most cloudy month	November.	December.	Dec. 1858 Dec. 1860 Feb. 1861	Dec. 1857.
When the mean of the month was	79	75	83	73
Least cloudy month	May & Aug.	August.	July, 1853.	June, '61, May, '62, Aug. '62.
When the mean of the month was	45	45	34	45
Average cloudiness of the least cloudy months in each year, irrespective of the time of year when they occurred ..	..	41	..	..

WIND.

	1862.	Result of 14 years.	Extremes.	
Resultant direction	N 48° W	N 60° W	..	..
Mean resultant velocity in miles	2.03	1.82	..	..

WIND—(*Continued.*)

	1862.	Result of 14 years.	Extremes.	
Mean velocity, without regard to direction	7.33	6.78	8.55 (in 1860).	5.10 (in 1853).
Month of greatest mean velocity	April.	March.	Mar. 1860.	Jan. 1848.
When the mean velocity was.	9.77	8.60	12.41	5.82
Month of least mean velocity ..	September.	July.	Aug. 1852.	Sept, 1860.
When the mean velocity was.	5.11	4.91	3.30	5.79

RAIN.

	1862.	Average of 21 years.	Extremes in 21 years.	
Total depth in the year in inches	25.529	30.324	43.555 (in 1843).	21.505 (in 1856).
Number of days in which rain fell	118	106	136 (in 1861).	80 (in 1841).
Greatest depth in one month fell in	July,	September,	Sept, 1843.	Sept. 1848.
When it amounted to	5.344	3.973	9.760	3.115
Rainy days were most frequent in	July & Aug	June,	June, 1857.	May, 1841.
When their number was	15	12	21	11
Greatest depth of rain in one day	1.555	2.138	3.360	..
Which fell on	April 21.	..	Oct.6,1849.	..
Greatest depth in one hour	0.845	..	..	..
Which fell between	6 a.m. and 7 a.m. July 23.	..	..	..

The distribution of rain through the day, both as regards depth and frequency, is given in the following table, derived from an hourly rain gauge in operation from April to November inclusive in 1861, and from April to October in 1862.

Periods.	6 A.M. to 10 A.M.	10 A.M. to 2 P.M.	2 P.M. to 6 P.M.	6 P.M. to 10 P.M.	10 P.M. to 2 A.M.	2 A.M. to 6 A.M.	Average of the six periods.
Depth, 1861	0.55	0.76	1.37	1.41	1.07	0.84	1.00
" 1862	1.18	0.93	1.00	0.92	0.97	1.00	1.00
" 1861 and 1862 combined	0.84	0.84	1.20	1.19	1.03	0.91	1.00
Frequency, 1861	0.84	0.84	1.02	1.06	1.08	1.16	1.00
" 1862	1.18	0.97	0.92	0.99	0.88	1.06	1.00
" 1861 & '62 combined	0.98	0.89	0.98	1.03	1.00	1.12	1.00

SNOW.

	1862.	Average of 19 and 22 years.	Extremes in 19 years and 22 years.	
Total depth in the year in inches	85.4	61.6	99.0 (in 1855).	38.4 (in 1851).
Number of days in which snow fell	72	57	87 (in 1859).	33 (in 1848).
Greatest depth in one month fell in	January.	February.	Feb. 1846.	Dec. 1851.
When it amounted to	27.4	18.0	46.1	10.7
Days of snow were most frequent in	January.	December.	Dec. '59. Jan. '61.	Feb. 1858.
When their number was	19	13	23	8
Greatest depth in one day	9.0	..	..	..
Which fell on	March 20.	..	..	..

RAIN AND SNOW (COMBINED).

Where ten inches of snow are considered as equivalent to one inch of rain.

	1862.	Average of 19 years and 22 years.
Total depth in the year	34.069	36.488
Number of days in which rain or snow fell	190	160*
Greatest depth in one month fell in	..	September.
When it amounted to	..	3.973
Days of precipitation most frequent in	..	December.
When their number was	..	18*

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* These numbers include the cases when both rain and snow fell in the same day, and which have been reckoned both in the rain and snow tables.

The accompanying table is a general abstract of the meteorological observations made at the Magnetic Observatory, Toronto, during the year 1862 :—

GENERAL METEOROLOGICAL

Provincial Magnetical Observ

LATITUDE, 43° 39′ 4″ North; LONGITUDE, 5h. 17m. 33s. West.—Elevation above

	JAN.	FEB.	MAR.	APR.	MAY	JUN.	JUL.
Mean temperature	21°.71	22°.50	28°.79	39°.56	52°.17	60°.52	66°.70
Difference from average (22 years)	— 1.82	— 0.48	— 1.34	— 1.42	+ 0.78	— 0.84	— 0.15
Thermic anomaly (Lat. 43° 40′ N.)	—11.09	—12.20	—11.31	—10.64	— 5.93	— 4.08	— 2.00
Highest temperature	44.5	37.8	43.2	68.0	78.5	85.4	95.5
Lowest temperature	— 2.6	— 5.2	8.0	14.5	32.4	39.4	48.2
Monthly and annual ranges	47.1	43.0	35.2	53.5	46.1	46.0	47.3
Mean maximum temperature	27.58	28.25	34.64	46.34	61.43	69.12	76.42
Mean minimum temperature	15.03	15.41	23.12	33.43	42.01	50.97	58.14
Mean daily range	12.55	12.84	11.52	12.91	19.43	18.14	18.28
Greatest daily range	25.8	30.0	23.6	23.5	37.0	31.8	31.9
Mean height of barometer	29.7274	29.6077	29.5036	29.7258	29.5895	29.5642	29.5474
Difference from average (18 years)	+.0940	—.0045	—.0787	+.1388	+.0049	+.0018	—.0540
Highest barometer	30.300	30.138	29.828	30.117	29.942	30.109	29.957
Lowest barometer	28.965	29.011	28.805	29.076	29.238	29.163	29.196
Monthly and annual ranges	1.335	1.127	1.023	1.041	0.704	0.946	0.761
Mean humidity of the air	.81	.84	.82	.73	.65	.66	.72
Mean elasticity of aqueous vapour	.103	.107	.132	.184	.253	.346	.473
Mean of cloudiness	.73	.78	.63	.65	.45	.60	.56
Difference from average (10 years)	+.02	+.07	+.04	+.07	—.07	+.07	+.10
Resultant direction of the wind	N 26 W	N 55 W	N 12 W	N 50 E	N 52 W	N 26 W	S 89 W
" velocity of the wind	2.69	3.93	2.50	2.48	2.80	1.77	1.42
Mean velocity (miles per hour)	8.83	8.52	9.38	9.77	7.87	5.98	5.80
Difference from average (14 years)	+0.97	+0.44	+0.78	+1.90	+1.25	+0.71	+0.89
Total amount of rain	0.115	0.180	2.560	2.235	1.427	1.007	5.344
Difference from average (21 & 22 yrs)	—1.292	—0.866	+1.012	—0.163	—1.814	—2.093	+1.854
Number of days rain	5	3	8	10	8	10	15
Total amount of snow	27.4	23.1	18.5	0.2	0.0	...	...
Difference from average (19 years)	+13.77	+ 5.07	+ 9.73	— 2.31	— 0.10	...	...
Number of days snow	19	17	11	4	0	...	...
Number of fair days	10	10	16	17	23	20	16
Number of auroras observed	4	1	2	5	5	2	6
Possible to see aurora (No. of nights)	11	10	13	16	20	17	20
Number of thunderstorms	0	0	0	1	1	3	8

REGISTER FOR THE YEAR 1862.

atory, Toronto, Canada West.

Lake Ontario, 108 Feet; approximate Elevation above the Sea, 342 Feet.

AUG.	SEPT.	OCT.	NOV.	DEC.	Year 1862.	Year 1861.	Year 1860.	Year 1859.	Year 1858.	Year 1857.	Year 1856.
° 67.60	° 59.59	° 48.70	° 35.58	° 28.78	° 44.35	° 44.22	° 44.32	° 44.19	° 44.74	° 42.73	° 42.16
+ 1.58	+ 1.68	+ 3.18	− 1.11	+ 2.67	+ 0.23	+ 0.10	+ 0.20	+ 0.07	+ 0.62	− 1.39	− 1.96
− 0.90	− 1.91	− 5.10	− 7.62	− 7.22	− 6.65	− 6.78	− 6.68	− 6.81	− 6.26	− 8.27	− 8.84
89.5	79.4	76.6	58.0	50.1	95.5	87.8	88.0	88.0	90.2	88.2	96.6
42.8	39.0	26.2	16.2	− 3.4	− 5.2	−20.8	− 8.5	−26.5	− 7.3	−20.1	−18.7
46.7	40.4	50.4	41.8	53.5	100.7	108.6	96.5	114.5	97.5	108.3	115.3
76.11	68.43	54.80	40.59	34.11	...	...	...	...	...	...	...
58.22	52.77	41.43	30.50	23.57	...	...	...	...	...	...	...
17.89	15.66	13.36	10.09	10.54	14.43	14.42	14.24	13.66	13.84	16.38	18.29
26.8	25.8	28.2	19.2	23.8	37.0	33.3	30.7	39.8	31.2	37.0	44.2
29.6161	29 6830	29.6188	29.6364	29.6778	29.6248	29.6008	29.5923	29.6209	29.6267	29.6054	29.5999
−.0052	+ 0201	−.0312	+.0225	+.0298	+.0115	−.0125	−.0210	+.0076	+.0134	−.0079	−.0134
29.977	30.031	30.039	30.469	30.453	30.469	30.330	30.267	30.392	30.408	30.361	30.480
29.326	29.107	29.047	29.132	29 105	28.805	28.644	28.838	28.286	28.849	28.452	28.459
0.651	0.924	0.992	1.337	1.348	1.664	1.686	1.429	2.106	1.559	1.909	2.021
.74	.80	.82	.80	.83	.77	.78	.77	.74	.73	.79	.75
.510	.418	.300	.171	.142	.262	.262	.260	.249	.259	.254	.244
.45	.47	.72	.79	.75	.63	.62	.60	.61	.60	.60	.57
.00	−.03	+.10	+.05	.00	+.03	+.02	.00	+.01	.00	.00	−.03
N 78 W	N 59 W	N 78 W	N 46 W	N 73 W	N 48 W	N 56 W	N 60 W	N 61 W	N 41 W	N 74 W	N 71 W
1.67	1.07	2.89	3.00	3.17	2.03	2.11	3.32	2.24	1.59	2.54	3.03
5.96	5.11	6.53	6.60	7.58	7.33	7.47	8.55	8.17	7.64	7.99	8.31
+0.79	−0.29	+0.67	−0.89	−0.60	+0.56	+0.70	+1.78	+1.40	+0.87	+1.22	+1.54
3.483	2.344	2.684	2.205	1.945	25.529	26.995	23.434	33.274	28.051	33.205	21.505
+0.532	−1.629	+0.199	−0.935	+0.400	−4.795	−3.329	−6.890	+2.950	−2.273	+2.881	−8.819
15	9	19	11	5	118	136	130	127	131	134	99
...	...	0.5	5.3	10.4	85.4	74.8	45.6	64.9	45.4	73.8	65.5
...	...	− 0.34	+ 2.20	− 4.26	+23.77	+13.17	−16.03	+ 3.27	−16.23	+12.17	+ 3.87
...	...	2	11	8	72	76	75	87	67	79	69
16	21	10	11	19	189	165	174	169	178	171	198
9	8	6	0	0	48	43	58	53	59	26	35
23	19	12	8	7	176	180	190	199	198	189	212
7	1	2	1	0	24	27	30	30	19	28	25

NOTES ON THE PRESENT CONDITION OF THE OIL WELLS OF ENNISKILLEN.

BY SANDFORD FLEMING, ESQ., C.E.

Read before the Canadian Institute, February 29, 1863.

During a recent visit to the village of Oil-Springs, in the township of Enniskillen, I made the following notes on the present condition of the oil wells in that quarter.

The first flowing well discovered, was that known as the "Shaw Well," on Lot 13 in the Second Concession. The oil was "struck" in the early part of last year, and continued to flow spontaneously for about ten months. This well was formed by digging about fifty feet through clay to the rock surface, and then by boring one hundred and fifty-eight feet through the latter. The flow from this well has now entirely ceased, after discharging a total estimated quantity of 35,000 barrels.

During the past summer, or at least since the first discovery of the Shaw well, there have been found in all about thirty flowing wells, of more or less value, in this section. The yield of all these wells, as I was informed, was at one time as much as 12,000 barrels per day. They are all situated within an area of one square mile, and chiefly on the south bank of the Black Creek; only one having been discovered to the north of it. The number of flowing wells is now reduced to two, an old and a new one recently opened. These two wells are within one hundred feet of each other, and yield, it is said, over one hundred barrels per day each. Many of the old surface wells are now brought into requisition; and such of the old flowing wells as yet afford oil by pumping, are worked by hand. The total yield from the flowing wells and all other sources, at the present time, is said to be about four hundred barrels per day.

There is one remarkable peculiarity connected with the stoppage of the natural discharge of oil from the wells, which might here be mentioned. The deepest wells invariably have been those which first ceased to flow; and the two shallowest of all the thirty wells, are those only which now yield a natural discharge of oil.

I ascertained the depth of nine separate flowing wells, at points scattered over the whole oil-producing area, to be as follows :

The deepest well......	G	......is 230	feet in the rock.
“ next deepest......	I	......is 208	“ “
“ “	B	......is 200	“ “
“ “	C	......is 182	“ “
“ “	H	......is 180	“ “
“ “	D	......is 162	“ “
“ “	A	......is 158	“ “
The shallowest wells	E	......is 109	At present flowing.
	F	......is 109	

It ought to be borne in mind, that I give the depths under the *rock surface,* not under the surface of the ground; the former being nearly level, while the latter is very uneven. Over the surface of the rock, the thickness of clay ranges from forty feet in the flats of the creek to eighty feet on the banks.

The deepest well (G) was the first to fail; in fact this one only discharged 4,000 barrels in all. The next on the list (I), the “Feroe” well, failed. Then the wells (B and C) at opposite extremities of the oil-producing area gave way. Then well H, in the centre, and close by the gum beds, ceased flowing. Then various intermediate wells failed; until now the only old well flowing is F, with a depth of one hundred and nine feet under the rock surface; and its companion (E), recently made, within thirty or forty yards of it, and to the same depth in the rock, yields a copious supply.

In ceasing to give a discharge of oil, these wells seem to give no previous indications of a coming change. The iron pipe which conveys the fluid from the bore in the rock to a convenient height above the surface of the ground, continues to yield a discharge; but this discharge is suddenly changed, in most instances, from petroleum to salt water, and the water flows on in a continuous stream, as did the former substance.

The mention of some apparent anomalies may be of interest to those who desire to form satisfactory theories regarding the various phenomena connected with the mineral oils.

1. In the immediate neighbourhood of all the flowing wells, and on the next lot to what is termed the gum-beds, the rock was bored to a depth of three hundred feet—seventy feet lower than the lowest well—without finding the slightest trace of oil.

2. About twenty yards from the flowing well marked I, a second bore was made in the rock to a greater depth by seven feet than the first well, without finding oil.

3. In another case, the rock was bored about fifty feet from a good flowing well, and twenty-five feet deeper, without success.

4. But perhaps the most singular case is the following:—Some time after the "Shaw" well flowed so successfully, a second party bored the rock to the same depth about one hundred yards from it, and found a copious discharge of oil, but this second well had the immediate effect of reducing very materially the flow from the "Shaw" well. When either was plugged up, the other yielded a full discharge; but when both were allowed to flow, each yielded only a partial supply. A third party, owning a small oil lot between the two wells, commenced boring on a line drawn from the one to the other, at the distance of about thirty yards from the "Shaw" well; he naturally expected to rob both wells, whilst their owners (who by this time had formed a cöpartnership) had every reason to fear his certain success. All parties, however, were doomed to disappointment, as the third well proved an utter failure, although the rock was bored to a much greater depth than the other two wells.

I may mention, that although traces of petroleum have been found at several places beyond the immediate neighbourhood of the village of Oil Springs, viz. at Bothwell, at Tilsonburgh, and at other points within a circle of perhaps ten or fifteen miles; yet, with one single exception, I believe no flowing well has been struck beyond the limited area shewn on the sketch. The exception referred to is at Petrolea, on Lot 14 in 18th Concession, Enniskillen, and about six miles from Oil Springs village. The rock is here bored to a depth of three hundred feet—five hundred and sixty-three feet under the surface of the ground—and a constant stream of salt water and oil is discharged, equal to, it is estimated, 1,200 barrels per day; and of this yield, about one per cent., or twelve barrels per day, is found to be petroleum.

There are, at the present time, a great number of refineries in the neighbourhood of the springs; I had no means of ascertaining the exact number, but I was told that, reckoning large and small, they could not number much fewer than one hundred. The capacity of these refineries is estimated to be equal to 1,500 barrels of crude oil per day, whilst the total yield of the springs is said to be not much more than four hundred barrels.

The "oil-men," although discouraged, are not without hope; they think that, as in Pennsylvania, an increased supply of Petroleum will be found, by sinking wells to a greater depth; and accordingly, they are making arrangements, if they have not already commenced, to sink a test well, to the great depth of one thousand feet under the surface.

I was informed, that although only about 150,000 barrels of Petroleum have been shipped, a total quantity of 300,000 barrels must have been discharged, up to this date, from all the wells; about half of the total yield having been allowed to run to waste. To give some idea of the capacity of the hidden reservoirs in which the Petroleum has been stored, I may mention that 300,000 barrels are equal to nearly 2,000,000 cubic feet; and that if brought into one place, the crude oil discharged from the wells of Enniskillen would be sufficient to cover an area of five acres of land to a depth of ten feet!

TRANSLATIONS AND SELECTED ARTICLES.

INTRODUCTORY LECTURE OF A COURSE ON REMOTE ANTIQUITY.

Delivered at the Academy of Lausanne in Nov. and Dec., 1860.

BY A. MORLOT.

[The following Lecture has been selected for translation, not so much on account of its intrinsic merit as for the interest of the subject therein discussed, and as an admirable specimen of the foreign style of investigation. In a work recently published by one of the editors of this *Journal*, ("Pre-historic Man"), the reader will find the same subject treated with greater elaboration, and with due regard to an authority which the continental *savan* is too often content to ignore. For the translation itself, at once faithful and spirited, the *Journal* is indebted to the pen of a lady.—Ed.]

To infer from the known to the unknown, from what we see to what we do not see, is the practice of the whole world. The Arab of the desert when he sees at a great distance an eagle soaring in the air, in a peculiar manner, exclaims: "a lion." He knows that this eagle is waiting for the moment to pounce in his turn on the prey that a lion will soon leave.

Without going to make so distant a search, we see that every one has more or less the habit of forming opinions in an indirect way. It is thus we judge the character of a man, by his language, by his writing, by his dress. The proverb has consecrated it: "The dress makes the monk."

It is in the main, by the same proceeding that the jurist arives at moral proof, and that the *savant*, or we should rather say the student, for the *savant* is but a perpetual student, works out his doctrine. He commences by observation, which he combines with experiment, when it is possible for him to interpose by modifying the circumstances under which the observed phenomena occur, and he classifies, he makes co-ordinate, he compares his first results, the better to seize their bearings, and at last, going back from effects to causes, he arrives at the discovery of the grand principles, the laws which govern nature. Observation, with experiment when possible, comparison, and at last inference, by these is science constituted.

One of the most beautiful examples of the application of this process, has been presented by Geology, that science which has been able to remake the history of our globe anterior to the existence of the human species. But why should we stop at the moment, when, for the first time, an intelligent being appeared on this earth, peopled until then bv animal creations, endowed only with instinct? Is not man also an element of nature, and does not he also belong to the great plan of creation? We shall be told, that for the human epoch, we have the transmission of recollections by written documents, that is to say, by history so termed, and by oral recital, that is by tradition. But before the invention of writing, what constituted history; and before the development of language, in what consisted tradition? The origin of writing is not so obscure: that is to say, the starting point of history proper does not date from very far back. The origin of spoken language goes back naturally much further. But the study of languages shows that they slowly and gradually developed themselves, coming from a very rudimentary condition, corresponding necessarily to an equally rudimentary state of thought.

When did tradition begin to form itself, when did history proper take its birth? It is difficult to decide. For Southern Europe, dated and registered history goes back several centuries before the

Christian era. For that part of Europe situated north of the Alps, the historical epoch hardly opens before the Roman invasion, that is to say, about the commencement of the Christian era. We have some historical data and certain traditions going back somewhat more remotely, but they have no great importance, with regard to the investigations which we propose to make, and we shall eliminate them.

It is, then, these ante-traditional and ante-historic times, these which we designate under the name of Remote Antiquity, (*Haute Antiquité*), and which we are to make now the object of our study; thus, in considering only Northern Europe to the Alps, and in stopping towards the commencement of the Cristian Era, our task is thus clearly limited, a fact which we must not lose sight of.

Since the recollections of this long epoch are almost effaced, we must seek another kind of material to re-construct the past. We find ourselves here in precisely the same position as the Geologist who re-establishes the history of our globe; from him we will borrow his method, and our course will present necessarily much analogy to his.

The chief materials of the Geologist are, the remains of the animal and vegetable creation; that is to say, petrifactions or fossils buried in the strata which form, in a great part, the mass of a continent.

Instead of fossils, we have the productions of art and industry, which are to us as a mirror in which is reflected the image of man, his life and his entire civilization; for, by his work, we recognise the workman. If from a bone the geologist is able to draw the complete animal, to which the piece once belonged, we can also as well with a single broken piece of pottery, reform the complete vase, and from the vase infer the maker. There is no extreme interval between a fragment of pottery and a human being, for everything holds together, everything is enchained in human economy, as everywhere in the reign of nature. The primitive inhabitant of our country has long ago disappeared, his mortal remains have returned to dust, his heroic narratives are forgotten, as well as his songs of love; the name even of the people—of the race lost; but the work of his hands still remains, and permits us to resuscitate our ancestors, to see how they lived and how they acted, to be present at their repasts, to examine their domestic industry, to recognize their commercial roads, to follow them to the chase and to battle, to surprise them in some of their religious observances, and to contemplate their funeral ceremonies. We thus transport ourselves into the past of our species, as the geologist has been able to make himself the contemporary of the phases of development of our planet. It is thus we understand the study of high antiquity or primitive Archæology.

We see that these researches deal with material objects, to vivify them and make them speak, as the geologist has the power of making stones speak. Nature is communicative when we know how to interrogate her; only we must not ask from times, when writing was unknown, to furnish us with proper names; for here they are entirely wanting,—whilst they play an important part in ordinary history. Thus, our studies will necessarily be limited to following the development of civilization, (in German *Cultur-geschichte*) in all that is allied to the acts of man, without touching speech. We can, to a certain point, *see* our ancestors but we cannot hear them, we observe them as if we were deaf and dumb.

It will be objected, perhaps, that to reconstruct thus the human past by means of the remains of industry, an abundance of means is necessary, which we do not possess; it will be said that antiquities are rare, and that fortunate discoveries are not frequent. But formerly it was thought fossils were also rare, and also exceptional; and now collections overflow with them, for they have been sought for and have been found abundantly, and beyond all expectation.

It is true, that with the exception of some monuments formed of great blocks and certain heaps of earth, time has rarely spared amongst the products of primitive industry those which rise above the surface of the earth. Especially is it the case in the countries with which we are occupied; and where the employment of masonry bound by mortar, dates only from the Romans. But let us consider that numerous generations have succeeded each other on the same ground—that they have sowed it with the minute remains of their activity, and that they have each in their turn passed away, carrying to their tombs what was most precious to them. We shall comprehend, then, that the vegetable earth, the mould, must be like one of those fossiliferous strata of the geologist, rich in documents of the past —only we must learn to find them, to recognize them, and to interpret them. The soil which we tread is veritably the tomb of the past—a vast grave, always open, and which will swallow us in our turn, with the remains of our industry, and to the profit of antiquaries to come.

It is equally true, that for the greater part of the time, the preservation of antiquities is but partial. Fleshy substances and vegetable matter have usually disappeared; and it is only metals, stone, pottery, glass, which have resisted. But it is the same with the remains of ancient organic creation, for it is in general but the solid parts of plants and animals that the strata of our globe have stored, under the form of fossils; nevertheless, the geologist has used them to much purpose. The task of the antiquary is not more difficult.

In certain cases, the preservation of the remains of antiquity is more perfect. Thus in turf-pits, and in the slime at the bottom of lakes, has been found vegetable matter, such as wood, certain fruits—even stuffs. When the object has been carbonised by fire, before falling in the water, it has become indestructible by chemical process. Thanks to this circumstance, there have been gathered in Switzerland even ears of wheat and bread, dating from several thousands of years. Far from being rare, the remains of antiquity will become abundant, as we seek for them better; and the materials to reconstruct the past of the human species will not be more defective than those by means of which the geologist reëstablishes the history of our globe.

It would seem, from that which precedes, that by beginning to form collections of antiquities, and by studying them rationally, in ever so trifling a degree, in no long time we ought to be able to know our true position, and to unravel the great features of our science—the fundamental principles of which are always very simple. Now, it is already long enough since we commenced to collect antiquities, but they were treated as fossils and many other objects of natural history were first treated; they were considered as mere curiosities when they were not made into amulets and charms. Then, when we desired to interpret their meaning, we began, as always happens at the birth of a science, by the most whimsical speculations, and by controversies as interminable as barren; so easily led astray is the human mind.

A proceeding which fetters progress still more, is that of attributing to the Romans all that is beautiful and skilfully worked, especially in objects made of metal, neglecting what is more ordinary, and arriving then, naturally enough, at the conclusion, that before the Roman invasion, the north of Europe to the Alps was only occupied by barbarous and savage hordes. Geology had to traverse a similar phase, when nothing could be seen in fossils but traces of the deluge.

These common mistakes have also prevailed in the south of Sweden and in Denmark, countries which abound in antiquities, and in which are found in particular numbers of axes and edges of flint. Some saw in these but instruments of sacrifice in Pagan times; others went so far as to believe these pieces proceeded from the thunderbolt, an origin which has also been attributed to certain fossils, such as belemnites. An idea can thus be formed of the state in which the question was found when the labors of M. Thomsen, Director of the Archæological Museum at Copenhagen, and of M. Nilsson, Professor of Zoology at the University of Lund in Sweden, commenced. These two illustrious veterans of the antiquaries of the North, too experienced to engage in the controversies then in vogue, set themselves to compare the antiquities of their countries with the products of industry among the people more or less savage of Oceanica and of other regions of the globe. This comparison led to a recognition of a remarkable similarity between the edged objects in flint of the north of Europe and the instruments of the modern populations who do not know the use of metals. Messrs. Thomsen and Nilsson remarked at the same time, that a whole series of northern tombs, characteristic enough, contained, in addition to the skeletons of the dead and pottery more or less coarse, instruments and arms of stone only, there being no relic of metal. They concluded naturally from this, that the first inhabitants of Europe had not known the use of metals, and had greatly resembled the savages of to-day, at least so far as relates to industry and material life. Another class of graves enclosed edged instruments and arms in metal, axes, knives, swords, lance-heads, but they were not made of iron or steel: they were of bronze, a mixture of brass and tin. Now, if iron had been known, it would certainly have been employed in preference to bronze, which is very inferior for all the purposes of cutting and carving. It follows then that bronze was known and used before iron, which was also brought into use later. Thus, the place taken by iron at the present day and for a long time past, with regard to industry and civilization in general, had previously been occupied by bronze, and, at a still more remote date, by stone. Thus we obtain the simple and practical distinction in antiquities of the age of stone, the age of bronze, and the age of iron. This classification, which recals that which Werner made of the geological strata into primitive, secondary, and tertiary, was introduced about thirty years ago. At first restricted in its application to the Scandinavian countries, it gradually extended to Germany, England, and Switzerland, and it now penetrates by Piedmont to Italy, rendering everywhere important services. We are now endeavouring to subdivide these three great principal phases in the development of civilization. The Danish antiquaries, at the head of whom is M. Worsaae, believe they can distinguish by the quality of the objects, and the mode of construction of the tombs, a first and second age of stone. The learned explorer of Mecklenburg, M. Lisch at Schwerin, thinks that the first centuries of the age of bronze were not acquainted with the casting of metal pieces, hollow inside, and that these indicate a considerable progress in the art of the founder, and characterise the last centuries of the age of bronze. At the same time, we begin to recognise in Denmark and in Switzerland a first age ante-historical of iron, and to distinguish it from a second age of iron joining on to historical times. In fine, it was necessary to begin by establishing, by means of large incisions (*coupures*), a small number of epochs clearly defined, as we at first established the great divisions of the earth in geology. But we are beginning now to recognise, as in geology, the indications of the gradual passing of one epoch into the other. Thus, although the presence of edged objects in bronze ordinarily excludes iron, there are, however, tombs like those at Hallstatt (Austrian Alps) which contain the bronze sword, with the iron knife or axe. But, then, an attentive study of the whole of the circumstances, shows that the tombs belong to a time of transition from bronze to iron. At Hallstatt, the transition evidently took place quietly and gradually. At other points, it seems to have been effected rudely enough, perhaps by the invasion of enemies, or by social revolutions, recalling geological perturbations which have so often established a decided difference between strata immediately superimposed.

We have just seen how the basis of our science has been established. This historical sketch has already revealed to us some fundamental principles; but it becomes us to consider more closely, and to place in detail our great means of practical research. In order to arrive at the comprehension of our species, we must naturally commence by learning its present state, by studying man, not only in civilised countries, but in following him wherever he has succeeded in establishing himself. That is to say, we must start from ethnology; and we have seen that it is precisely this proceeding which has most contributed to put the antiquaries of the north on the right path. Thus ethnology is for us, what physical geography is to the geologist. For we can understand the philosophy of the past of our globe only by first studying its present state, and by following the changes which operate on its surface, as Lyell, the reformer of geology, has so well taught us. Different people have had, in all times, their particular manner of fashioning and ornamenting the objects which they made, and they have always had their different habits, with which was connected the employment of particular objects. This is what constitutes what is vulgarly called the fashion, or, to use a more scientific term, style. In the north of Europe to the Alps, style or fashion, has always been uniform enough for a given period, but has constantly varied from one epoch to the other, precisely as fossil species have changed in type from one geological epoch to the other. The exterior character of an object often permits us to determine its age and that of the burial mound to which it belongs, as we can determine the age of a geological stratum by means of a single fossil when it is characteristic. In the north of Europe, bronze bracelets were worn during the age of bronze, and during the first age of iron; but their style was different, the fashion had changed. Thanks to this circumstance, we shall seldom be embarrassed when it is necessary to determine the age of a bronze bracelet, or even a fragment of such a bracelet. It does not suffice when we make excavations to gather antiquities to form collections. It is of the greatest interest to observe their associations, to determine what are the objects which are found together and are consequently of the same date, as it is of importance to reunite the fossils of the same strata. Taken separately, the latter often might not signify much, whilst together they may throw the brightest light on a whole phase of the past of our globe. In this view, tombs have a great importance, for they present collections of objects of the same date, without taking into account that the mode of sepulchre itself has varied from one epoch to the other, which again adds to the value of the observations. We have seen that the study of tombs has thus contributed much to putting the antiquaries of the north on the right road. The question of arrangement, so important in geology, is not less so as regards the remains of antiquity. The particular grouping of objects on the points where they meet, has often a special signification. Thus, to return to the tombs, their interior constitution, considered with care and minuteness, will reveal the funeral ceremony, and may furnish notions of the religious ideas and the different customs of the epoch. Sometimes, and it is found the most ancient custom, the body of the dead has been doubled down with the knees to the chin, as if to occupy the least possible space. At other times the body has been burnt, which would make us suspect fire-worship. Then the dead body has often been stretched at full length. Then there are several contemporary skeletons in the same tomb. Their particular arrangement and the whole circumstances would make us conclude that they were human sacrifices. We should find in this case the victims as if they had been thrown there negligently, whilst the central point had been reserved to the personage in whose honour the burial and sacrifices had been made. In observing the distribution of certain flints and fragments of pottery in the earth, accumulated on ancient sepulchres, Dr. Keller has inferred the custom of throwing these objects on the grave during its construction, which a curious passage of Shakspeare (*Hamlet*, Act V., Scene 1),* goes to confirm.

It would seem that the funeral ceremony was sometimes connected with a feast on the spot, and that, immediately after, the vases which had been used at the repast were broken, and the fragments scattered on the grave. At other times, entire vases, crushed by the pressure of the earth, appear to have contained provisions for the dead with whom they also buried his dress, arms, or other attributes of his trade, down to his dog, his horse, or even his wife.*

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* *Note by Translator.*—We are referred by a note to the Memoirs of the Society of Antiquaries of Zurich (Vol. III., Cahier V., 1845), in explanation of this passage. Not being able to turn to the authority, we can only suppose that reference is made to the burial of Ophelia. The poet says,—

"Her death was doubtful;
And, but that great command o'ersways the order,
She should in ground unsanctified have lodg'd
Till the last trumpet; for charitable prayers,
Shards, flints, and pebbles, should be thrown on her,
Yet here she is allowed her virgin rites,
Her maiden strewments, and the bringing home
Of bell and burial."

"Maiden strewments" were the flowers and garlands which affection and devotion cast over the coffin of the young, as it were as a type of their innocence. It will be recollected as the Queen scatters flowers over Ophelia's grave, she says, "Sweets to the sweet." Our Protestantism has driven this ceremony from our churchyards, but it is a common practice in Southern Europe to this day.

To the question of arrangement (*gisement*) is attached the order of superposition, which plays so essential a part in geology, as thence directly results the chronological order of succession of the different

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**Note by Translator.*—Some light is thrown upon this opinion by Mr. DuChaillu, in his late Explorations in Eastern Equatorial Africa, a country as primitive in its barbarism as we would wish to adduce as an example. The light of civilization reflected from the slave dealer, who appears to be the only representative of western development, must be necessarily small. Evidently, his success depends on depressing rather than elevating the savages with whom he comes in contact; so we may consider that we have in this section of the world, a man almost in the first stage of progress or the last of decadence.

"Near Feitch Point is the Oronugon burying ground, and this I went to see the following morning. It lay about a mile from our camp toward Saugatauga, from which it was distant about half a day's pull in a canoe. It is in a grove of noble trees, many of them of magnificent size and shape. The natives hold this place in great reverence, and refused at first to go with me on my contemplated visit, even desiring that I should not go. I explained to them that I did not go to laugh at their dead, but rather to pay them honor. But it was only by the promise of a large reward that I at last persuaded Niamkala, who was of our party, to accompany me. The negroes visit the place only on funeral errands, and *hold it in the greatest awe*, conceiving that here the spirits of their ancestors do wander about, and that these are not lightly to be disturbed. *I am quite sure that treasure to any amount might be left here exposed in perfect safety.* The grove stands by the sea shore; it is entirely cleared of underbrush, and, as the wind sighs through the dense foliage of the trees, and whispers in the darkened, somewhat gloomy grove, it is an awful place, even to an unimpressible white man. Niamkala stood in silence by the strand while I entered the domains of the Oronugon dead.

"*They are not put below the surface.* They lie about beneath the trees in huge wooden coffins, some of which, by their new look, betokened recent arrivals; but by far the greater number were crumbling away. There was a coffin falling to pieces, and disclosing a grinning skeleton within. On the other side were skeletons, already without covers, which lay in dust beside them. Everywhere were bleached bones and mouldering remains. *It was curious to see the brass anklets and bracelets in which some Oronugon maiden had been buried, still surrounding her whitened bones; and to note the remains of goods which had been laid in the same coffin with some wealthy fellow, now mouldering to dust by his side.* In some places *there remained only little heaps of shapeless dust, from which some copper, or iron, or ivory ornaments gleamed out to prove* that here, too, once lay a corpse.

"Passing into a yet more sombre gloom, I came at last to the grave of old King Pass-all, the brother of the present Majesty. *The coffin lay on the ground, and was surrounded on every side with great chests, which contained the property of his deceased Majesty. Among these chests and on top of them were piled huge earthenware jugs, glasses, mugs, plates, iron pots and bars, brass and copper rings,* strata, one stratum deposited on another being necessarily the most recent of the two. The antiquary has seldom a regular series superimposed like the strata of the geologist. It would be more often the case if we could examine the deposits which are formed at the bottom of lakes and seas. But in that case the geologist would have had the precedence, and would have traced the history of human kind so as to leave very little to glean after him. The materials of the antiquary are ordinarily all hidden in a thin layer of vegetable earth, and even this is sometimes wanting. There are, however, cases of superposition of deposits of human traces on dry ground; they are of great value, for they establish better and more surely than in any other manner the chronological order of succession of the different epochs. Thus all distinction of ages ought to be capable of being referred to direct observations of superposition of layers or deposits which would correspond to these ages. We have seen how the *savans* of the north arrived at their three ages of stone, of bronze, and of iron. Their result is without doubt very beautiful and satisfactory; but they have obtained it by a rather indirect way, and thus it is sometimes still contested. Here is one of these observations, since there is need of such to decide the question definitively. At Waldhausen, near Lubeck, existed one of these ancient tombs in the form of a hillock, or barrow, of 13 feet in height by 161 in circumference. It was examined by entirely levelling it. Under the summit was discovered a tomb of the age of iron, but very ancient, according to all appearance ante-historical. There was a skeleton in the mere ground, with fragments of coarse pottery, and a piece of iron eaten with rust. Lower down, about mid-way, three graves of the age of bronze presented themselves. They were small recesses in dry walls, containing each a cinerary urn filled with the remains of calcined bones, to which were added different objects in bronze, such as necklaces, hair pins, and a knife. At last at the base of the hillock was a tomb of the age of stone, formed with great rough blocks, and enclosing among other things coarse pottery and flint axes. Evidently the first inhabitants of the country had constructed, on the flat and natural soil, a tomb, according to the

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and other precious things which this old Pass-all had determined to carry at last to the grave with him. And, also, there lay around *numerous skeletons of the poor slaves who were, to the number of one hundred, killed when the king died*, that his ebony kingship might not pass into the other world without due attendance." —*Explorations and Wanderings in Equatorial Africa, by Paul B. DuChaillu*, 1862; chapter xii.

custom of the time, and had covered it with earth; on the elevation thus produced they had, during the age of bronze, practised the funeral ceremonies of the epoch, and covered the whole with earth, doubling the height of the hillock. Finally, in the age of iron they had buried a corpse by digging a grave at the top of the tomb. What appeared at first one grave may thus furnish objects of very different ages, and it is of great importance to execute the search with the necessary care in order to determine the exact position of what is found there, if we do not wish to fall into grave errors. Messrs. Castan and Delacroix, at Besançon, surprised at finding objects apparently brought together, the association of which did not appear to them natural, succeeded in establishing in the interior of the same grave, not of great elevation, interments of the Roman epoch superposed on Gallic graves of the first age of iron. They have thus decided the question of an indigenous civilization possessing iron, and anterior to the arrival of the Romans.

But the observations of superposition, notwithstanding all their worth, furnish only data of relative chronology, like those of geology, which does not recognise absolute dates; and yet we should like to know, when each of the three ages of stone, of bronze, and of iron commenced, and how long they each lasted. The most simple answer is to avow that we do not know. The introduction of iron is already an ante-historical event, even ante-traditional; how much more reason then, that the preceding ages of bronze and of stone should be beyond all recollection? It is only with the concurrence of geology that a solution of the problem can be arrived at; here is an example which shows how the data of absolute chronology may be obtained.

The alluvium of the torrent of the Tinière, which empties itself in the lake of Geneva, at Villeneuve, forms a cone of deposit, (*dejection*) regular enough,—a delta in the shape of a fan, of about 100 degrees of opening, 900 feet radius (at its least), and 4 degrees inclination. The works of the railroad have cut through this cone, perpendicularly to its axis, through a length of 1000 feet and a height, attained in the central or the most elevated part of the cone, of 32½ feet above the definitive level of the rails. The cut obtained may then be represented by an arc of a circle, or if we wish it, by a hyperbola, its vertex being elevated 32½ feet above a subtending chord of 1000 feet.

The interior constitution of the cone, thus opened, was found to possess great regularity, a proof that the formation of the cone took place gradually. The same rolled materials were seen in it, sand, gravel, and blocks, precisely as in the actual deposits of the torrent. There are a great many little differences in the constitution of the torrent from one year to another, but it is evident that in the end there is a compensation, and that when we go on to consider the series of centuries and the whole of the cone, as we do here, the influence of these temporary variations, depending on meteorological variations, disappear entirely, leaving apparent only the average and regular growth of the cone. We must also consider, that the alluvium of the torrent is fed by the degradation of the surface of its hydrographical basin, which necessarily contributes much to regulate the growth of the cone. This hydrographical basin is itself regular enough, and although its surface is much inclined, it does not present land slides or other accidents, which could have troubled the course of the torrent. The partial denudation of the hydrographical basin in modern times, may have accelerated a little the superficial degradation; but if this effect has been sensible, which is doubtful enough, an augmentation would result from it, and not a diminution of the dates which we are going to deduce. Modern embankments having driven the torrent a little to one side, towards the right shore, on the inclining or north flank of the cone, the alluvium has concentrated itself on this side, and has since then more forcibly raised the surface of the soil, since it could no longer reach the southern fall of the cone. The documents preserved in the archives of Villeneuve, prove that these embankments date from the year 1710, and their recent date is confirmed by the small thickness in the covering of vegetable earth on the incline of the cone protected by the dykes; there was not, where the culture of the earth had not intervened, more than two or three inches (six to nine centimetres), including the length occupied by the radicle of the turf. In this southern plane, thus protected by dykes, the works of the railway brought to light three layers of ancient earth, situated at different depths, and which had each in its time formed the surface of the cone. They were regularly intercalated in the gravel of the alluvium of the torrent, and exactly parallel to each other, and to the present surface of the cone, which was itself quite straight, and regularly inclined four degrees, following the line of the sharpest descent. It is evident that this parallelism of the layers between themselves and the present surface, proves, in the most direct manner, the regularity with which the cone has grown. The first of these ancient layers of vegetable earth, was followed, in the southern flank of the cone, on a surface of more than 15,000 square feet, it was from four to six inches in thickness, (twelve to eighteen centimetres) and was formed at a depth of four feet, (more exactly 1·14 metres, measured to the base of the layer) under the present surface of the cone. It dated from the Roman epoch, for it contained fragments of Roman tile, and there was found a Roman coin much defaced, but appearing to be anterior to the lower empire. The second layer of ancient earth was followed in the southern flank of the cone, on a surface of about 25,000 square feet, it was six inches thick, and was found at ten feet (more exactly at 2·97 metres, measured to the base of the layer) under the present surface of the soil. It afforded some fragments of pottery not varnished, and tweezers in melted bronze, characteristic by its style of the age of bronze. The third of these layers of ancient earth was exposed to view in the southern flank of the cone, on a surface of about 3,500 square feet; it was from six to seven inches thick, and was nineteen feet (more exactly 5·69 metres) under the present surface of the soil. It furnished fragments of very coarse pottery, of charcoal, bruised bones of animals, evidently the remains of repasts, and a human skeleton whose skull * was very round, very small, and remarkably thick, presenting the Mongol type.

This third layer can only be referred to the age of stone, although we have not had the good fortune of meeting a stone-axe, or anything of that kind. Let us note, that on one point of the southern flank of the cone, some charcoal was again found in a layer of gravel, a foot lower than the layer of vegetable earth of the age of stone; that is to say, twenty feet (more exactly at 6·09 metres) in depth, under the present soil. Let us note further, that under the layer of earth of the Roman epoch, there presented itself no trace of brick or tile. This is not without interest, when we know that the art of baking brick and tile was imported by the Romans to this country. Towards the centre of the cone, in the most elevated part of the cist or trench, the three layers in question disappear,—naturally, for it is here that the torrent has always had the greatest force, and that it has deposited the coarsest materials, comprehending round blocks about three feet in diameter, such as we see in the bed of the torrent. The more the torrent deviated to the right or the left of the central region of its delta, the smaller

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* We learn that this skull was examined, measured, and determined, by J. M. P. Montagu, Esq., well known in the scientific circles of Montreal, some fourteen years back.

were the materials which it deposited on the two inclines of its cone; and the more easily could a layer of earth formed on the surface, after the preceding great inundations, remain in its place and be hidden under new alluvium; whilst towards the centre of the delta or cone, it must have been swept away by the violence of the water. Likewise, we further found in the gravel of the southern incline of the cone, at a point where the layer of earth of the age of bronze had disappeared, but still at ten feet in depth under the present surface, a hatchet in bronze, oxydised, and a bronze axe well preserved, which had not been rolled; the weight of these two objects would have made them remain in this place, whilst the earth which surrounded them apparently had been carried over by the torrent. If the three layers of ancient earth in question thus disappeared on one side, as they approached the centre of the cone, they re-appeared symmetrically on the other side, in the southern flank. They were never at a greater depth under the present surface; for the torrent, as we have seen, has concentred its alluvium on this incline, but they were always parallel to each other, and the vertical distances which separated the one from the other, were sensibly the same as on the other side of the centre, in the southern incline of the cone. There was, thus, in the northern flank of the cone, six feet in depth of the Roman layer, sufficiently thin at this point, based on the layer of the age of bronze, and ten feet in depth, of this latter, on the layer of the age of stone; we could not be mistaken in the layers, and take one for the other. That of the age of stone was too little interrupted in the centre, for it to be possible to mistake the direction it was necessary to take to find it again. The layer of the age of bronze was interrupted to a greater extent, but it could be distinguished in the two sides by its particular character. It was formed of a bluish clayey earth, resembling in appearance blue frozen mud, and bounded towards its upper and lower limits, by more sandy zones, coloured yellow by hydroxyde of iron and producing the effect of two layers, encasing between them the bluish bed; it was remarkable and indicates some particular cause. The deposit of the age of stone occasionally presented an analogous appearance; but it was only in spots, and not with the continuity of the age of bronze. As to the Roman layer of the northern side, it was known only by its height above the stratum of the age of bronze; no fragments of Roman tiles were found, but it was here only observed for a limited extent, in a length of about forty feet; whilst the stratum of the age of bronze showed itself in the northern side, very distinctly and regularly, for a length of 200 feet.

After all which precedes, we can see that it would be difficult to imagine a greater regularity in the entirety as well as in the details of the phenomena, and this circumstance renders perfectly legitimate the application of our calculus. So then, taking our departure from the observations and measurements made on and in the decline of the southern side of the cone, keeping account of the effects of the embankments, but augmenting their age to double; that is to say, giving them a date of three centuries, taking notice of the thickness of the vegetable earth on the present surface, considering that the volume of the cone increases as the cube of its radius, and that the depths of its different strata are thus not exactly in direct ratio with their age, and giving finally to the Roman layer an antiquity of at least thirteen centuries, or at most eighteen, although nineteen centuries have passed since the Romans invaded this country, we find for the layer of the age of bronze an antiquity of at least twenty-nine centuries or forty-two at most; for the layer of the age of stone an antiquity of at least forty-seven centuries or at most seventy; and for the whole of the cone a total age of seventy-four or at most 110 centuries. The author believes that we would approach near enough to the truth, by deducting only two centuries for the action of the dykes, and attributing to the Roman deposit an antiquity of sixteen centuries; that is to say, in bringing it to the third century of the Christian era. This would give to the layer of the age of bronze an antiquity of thirty-eight centuries, twenty centuries before Jesus Christ; and for the age of stone an antiquity of sixty-four centuries. But in order not to risk being too precise in counting the centuries, we will stop at the assertion, that the layer in question of the age of bronze has a date of from 3000 to 4000 years, and that of the age of stone from 5000 to 7000 years.

It is evident that each of our ancient soils would not represent the total length of each of the corresponding ages, but only some portion of each of these ages, the small period more or less long, during which the torrent has worked in the central region of its cone, without spreading itself on its sides, where vegetation could then have taken place. The surface of the cone, for the greater part of the time, must only have presented the appearance of a heap of stones, on which a few bushes grew. Thus we have not remarked traces of human occupation in the gravel intercalated between the three layers of ancient earth in question. The argillaceous nature of the latter appears to indicate that they owe their origin perhaps to inundations of an exceptional nature, forming deposits more muddy than stony, and this would have favored the development of vegetation, and thus have attracted man to the spot. Here might be raised the objection that, our three layers having been deposited by the torrent, the ancient *débris* which they have furnished could equally have been brought here by the torrent, which might have brought them from elsewhere; and in this case the age of the three layers would remain undetermined. But the ancient remains had been well preserved and had not been rolled by the torrent; the fragments of pottery and baked earth were angular, as were also the small pieces of charcoal disseminated in each of these three layers, which also all three contained whole shells, although very fragile, of different species of land mollusca. The objection is therefore inadmissible.

Let us remark here that the minimum date of twenty-nine centuries for the layer of the age of bronze corresponds well with deductions, purely archæological, which on their part also bring back the introduction of iron into our countries to at least a thousand years before the Christian era. This identity is so far complete that the character of the tweezers found in the layer of the age of bronze indicates rather the end than the beginning of that age: so that if this minimum of twenty-nine centuries for the date of the layer of the age of bronze conforms to truth, that of forty-seven centuries for the layer of the age of stone, and of seventy-four centuries for the age of the entire cone, is so, *a fortiori*, in virtue of the calculation itself, whilst the maxima obtained may have remained below the reality. The maximum of 110 centuries in particular for the age of the entire cone, is evidently under rather than over the real figure. It would result, nevertheless, from the date found, that the modern geological epoch, to which the cone or delta of the Tinière corresponds, has not been very long, and that very soon after its commencement man invaded Europe, which is confirmed by the study of the turfy marshes in Denmark and Switzerland. Flints, cut by the hand of man, found in England and France in gravel, along with bones of elephants (*elephas primigenius*) and of other extinct species, make the apparition of man in Europe go back beyond what we ordinarily consider the modern geological epoch.

We have thus endeavoured to conquer for remote antiquity the data of absolute chronology, expressed in thousands of years. The occasion has been singularly advantageous it is true, but it has the great drawback of being the first and only one of its kind. Let us hope that others as favorable will present themselves, from which we may obtain good results; for as long as a fact remains isolated, the indications which we draw from it cannot be controlled by comparison, and the mind cannot rest entirely satisfied.

But what is the benefit of all these researches in the past when the present suffices to absorb us?

The question is legitimate, and it is right that we should conclude by some remarks on the end and utility of our study. When the philosophers of Ancient Greece exercised the subtilty of their minds in developing the properties of the conic sections, they did not imagine that they were laying the base of those modern processes by which we calculate astronomical tables, serving to guide the sailor in his course across the ocean. And now we no longer ask, what is the use of mathematics!

It is not a century since geologists would have been embarrassed to explain the practical utility of their researches. Now it is easy to answer by furnishing the most satisfactory examples of the application of geology to industry.

All real knowledge, the simplest secret drawn from nature, has necessarily its value, and will find, soon or late, its application in contributing to the well-being of humanity. But Science also requires time to clear its land, to work it, to sow it, and to ripen the harvest.

Besides, primitive Archæology is very young, younger even than its sister Geology; we must therefore not be astonished if it cannot glorify itself about the great services that it has already rendered. There are, however, some words of apology in its favor.

We really know a man only by his past life, by his youth, by his education, and by the whole of his antecedents; precisely as the naturalist does not thoroughly know an organic being until he has followed its development from the first germ. In the same way, the study of the past of humanity is indispensable in learning to appreciate its present state, and to arrive at the comprehension of the social relations which regulate the life of nations. Thus it will be a real gain, when the progress of scientific researches on the development of humanity shall have silenced these modern discussions, to which may be applied the bitter but true remark of the mathematician Littrow, relative to the scholastic controversies of the middle ages, viz., that to argue a subject well, the two parties must know nothing of it, seeing that if one understands something of it, the discussion is soon ended, and that when both see it clearly they cannot even commence.

Lastly, if the astronomer has succeeded in foretelling the movements of the celestial bodies because he has found out the laws of them, may we not hope with Condorcet that, if once the present condition of humanity be well understood as a necessary result of its past, we may succeed in sounding a little the mystery of its future! We are studying the past in order to comprehend the present, and possibly to obtain a glimpse of the future.

M. M. K.

SCIENTIFIC AND LITERARY NOTES.

SALT WELLS OF MICHIGAN.

Professor Winchell has sent us a copy of his paper on the Saliferous Rocks and Salt Springs of Michigan, published in a recent number of the *American Journal of Science* (November, 1862). According to the author, the brine-holding strata of Michigan occupy three distinct geological positions. The lowest saliferous beds form part of the Onondaga Salt Group of the Upper Silurian Series, but these have not as yet been thoroughly explored. Seven hundred and fifty feet above the Onondaga deposits, lie the strata known as the Michigan Salt Group, the source of supply being probably the "Napoleon Sandstone" at their base. These strata have been fully discussed by Prof. Winchell in his "First Biennial Report." They belong to the horizon of the upper part of the Carboniferous limestone formation. Still higher in the series, the so-called "Parma Sandstone," immediately beneath the coal-measures proper, has been found to furnish a third supply of brine. The wells first sunk at Bay City, derived their supply from this source, but the borings are now carried down to the lower-lying Napoleon sandstone. The daily supply from these wells, along the Saginaw Valley, is stated to be "at least 25000 gallons each"—their united daily produce, with 22 blocks of kettles in operation, being about 1210 barrels. The cost of manufacture, per barrel, does not exceed sixty-four cents.

FOSSIL REPTILES FROM THE COAL-MEASURES OF NOVA SCOTIA.

The bones and other portions of Carboniferous reptiles, discovered some time ago by Dr. Dawson in Nova Scotia, have been examined by Professor Owen (*Journal of Geological Society*, August, 1862). The materials collected are referred to several distinct species of *Hylonomus* and to one species of *Dendrerpeton:* genera belonging to the Ganocephalous Order of Professor Owen's last classification. The author observes:—"*Dendrerpeton*, like *Hylonomus* and *Archegosaurus*, shows the affinity (if it may be so called) or analogy to the ganoid fishes, not only in the character of the cranial bones, but in the retention of a covering of the body by ganoid scales: these are elliptic, smooth on their inner surface, with a slight indication of a ridge, about half the length of the scale, on the external surface—at least, in certain of the scales, and probably those along the back. The genus *Hylonomus* also, although with more minute and simple teeth, had the skin defended by similar elliptic or suboval ganoid scales. Much remains to be determined as to the structure of the skull; nevertheless such cranial bones as have been obtained, exemplify the Ganocephalous sculpturing; while the arrested state of ossification of the endoskeleton, and the characters of the limb-bones sustain the reference of the genus to the Order Ganocephala. After careful scrutiny of all the specimens confided to my inspection by Dr. Dawson, I have not met with any decisive evidence of a member of any of the orders of *Reptilia* represented by species of the Oolitic or later series of deposits. Some, as (*e.g.*) *Baphetes*, may be Labyrinthodont, but the rest are Gonocephalous; and *Baphetes* may possibly belong to this lower group of palæozoic air-breathing vertebrates."

CANADIAN INSTITUTE.

SESSION—1862-63.

FIRST ORDINARY MEETING—6*th December*, 1862.

No Quorum

SECOND ORDINARY MEETING—13*th December*, 1862.

Hon. J. H. Hagarty D.C.L., President, in the Chair.

I. George Beardmore Esq., elected provisionally by the council during the recess was balloted for, and declared duly elected.

II. *Donations received since the last meeting of the Institute were announced (see annual report.)*

III. *The following Papers were then read:*

By the Rev. Prof. W. Hincks, F.L.S.

"On certain vegetable monstrosities considered in reference to the question of the reality and permanence of species amongst organized beings."

P. Freeland, Esq. "Exhibited and described Smith and Beck's new universal Microscope."

IV. The requisite nominations for the election of office-bearers for the ensuing year were made, and the President announced the Annual General Meeting to be held on the 20th inst., to receive the Report of the Council, to elect office-bearers and members of Council for the ensuing year and for other business.

V. Prof. Chapman gave notice that at the meeting to be held on the 10th Jan., 1863, he would propose an amendment to the By Laws, Sec. VII. Regulation 1, to the effect that the words "Editor of the Journal" be added to the list of office-bearers, immediately before the words "and six other members."

ERRATA.

In the No. for March, page 137, line 12, *for* that of a man, *read* that of a woman.

" " page 159, *for* $\frac{\Delta X}{X} - \frac{\Delta Y}{Y}$ *read* $\frac{\Delta Y}{Y} - \frac{\Delta X}{X}$

" page 163, foot-note, *for* from 1848 to 1860, *read* from 1844 to 1848.

MONTHLY METEOROLOGICAL REGISTER, AT THE PROVINCIAL MAGNETICAL OBSERVATORY, TORONTO, CANADA WEST,—FEBRUARY, 1868.

Latitude—43 *deg.* 39.4 *min. North. Longitude*—5 *h.* 17 *m.* 33 *s. West. Elevation above Lake Ontario,* 108 *feet.*

Day.	Barom. at temp. of 32°.				Temp. of the Air.				Excess of mean above Normal.	Tens. of Vapour.				Humidity of Air.				Direction of Wind.			Resul't. Direction.	Velocity of Wind.					Rain in inches.	Snow in inches.
	6 A.M.	2 P.M.	10 P.M.	Mean.	6 A.M	2 P.M	10PM	ME'N		6 A.M	2 P.M.	10 P.M.	M'N	6 A.M	2 P.M.	10 P.M.	M'N	6 A. M.	2 P. M.	10 P. M.		6 AM.	2 PM.	10 P.M.	Re-sul't.	ME'N		
					°	°	°	°	°												°							
1	29.568	29.197	—	—	30.9	33.4	—	—	—	.157	.178	—	—	.90	.93	—	—	s b w	s b E	w b s	s 51 w	10.5	11.7	30.0	13.22	17.37	0.085	0.4
2	.556	.636	29.726	29.6547	17.2	18.3	6.0	13.47	—10.38	.068	.074	.055	.062	.72	.74	.95	.76	w b s	w	N b w	N 79 w	18.5	16.8	4.2	11.27	13.00	...	...
3	.807	.875	30.125	.9663	1.7	8.2	- 5.2	-0.18	—23.95	.038	.046	.032	.036	.80	.73	.90	.80	N	N N W	N N E	N 16 w	7.8	14.2	10.0	10.67	11.23	...	...
4	30.407	30.465	30.387	30.4123	-19.8	- 3.7	7.8	-4.52	—28.20	.016	.038	.051	.034	.87	.93	.82	.84	N N w	N E b N	E b s	N 71 E	7.0	10.0	16.2	10.19	12.72	...	1.0
5	30.122	29.924	29.683	29.8882	15.4	21.5	28.4	22.67	— 0.92	.077	.109	.148	.116	.87	.92	.95	.92	E b s	s E b E	E s E	s 65 E	17.0	12.0	13.0	12.66	13.31	...	16.0
6	29.502	.444	.719	.5733	24.8	25.2	24.4	24.67	+ 1.15	.126	.118	.117	.120	.95	.87	.89	.91	N E b E	N W	W	N 66 w	10.5	4.8	8.3	5.16	7.59	...	2.0
7	.837	.822	.899	.8667	23.3	29.8	23.0	24.37	+ 0.93	.110	.109	.106	.104	.87	.66	.86	.80	s w b w	s w b s	w b N	s 51 w	11.8	16.0	3.0	9.35	10.01	...	...
8	30.001	30.021	—	—	19.7	32.4	—	—	—	.096	.153	—	—	.91	.83	—	—	w s w	W	N	N 3 E	2.0	4.0	10.0	5.47	7.33	...	0.1
9	30.033	29.789	.368	.7113	24.8	26.2	34.9	29.27	+ 6.00	.120	.110	.199	.151	.88	.77	.98	.89	E b N	E	s s E	N 84 E	12.3	17.0	3.2	2.64	15.82	0.630	2.0
10	29.632	.854	30.018	.8598	31.3	30.6	25.1	27.97	+ 4.70	.143	.131	.108	.123	.81	.76	.80	.80	w b N	N W	Calm.	N 66 w	23.2	13.2	0.0	10.33	10.54	...	Inp.
11	.968	.815	29.695	.8173	21.5	30.6	25.5	25.93	+ 2.67	.102	.115	.118	.111	.88	.67	.86	.80	N b E	E s E	N N E	N 80 E	3.8	8.0	6.5	3.49	5.96	...	...
12	.623	.553	.723	.6448	24.4	27.3	19.0	23.52	+ 0.27	.110	.133	.078	.104	.84	.89	.77	.81	N N E	N N E	N w b N	N 10 W	1.0	6.2	9.5	7.45	8.25	...	0.1
13	.921	30.005	30.106	30.0255	3.5	20.8	10.0	11.72	—11.55	.044	.077	.059	.061	.87	.69	.87	.80	W N W	N W	N N E	N 7 E	4.5	1.8	6.8	3.48	4.51	...	...
14	30.035	29.743	29.412	29.6907	20.1	27.7	34.2	28.72	+ 5.45	.091	.106	.187	.134	.85	.70	.95	.82	E s E	E b s	s b E	s 29 E	9.0	15.8	8.0	7.68	14.50	0.045	...
15	29.472	.617	—	—	34.9	35.6	—	—	—	.176	.123	—	—	.86	.59	—	—	w b s	W s w	s W b W	s 80 w	14.5	22.0	11.0	16.19	17.02	...	...
16	.980	30.071	30.068	30.0515	24.1	26.2	16.8	22.05	— 1.32	.093	.103	.073	.089	.72	.73	.78	.74	W N W	N W	N E b N	N 32 W	19.8	5.5	2.0	4.35	6.23	...	...
17	30.001	29.870	29.835	29.8935	19.4	30.9	24.1	24.80	+ 1.45	.087	.083	.107	.096	.83	.48	.82	.73	N N E	E N E	N E	N 54 E	5.5	11.0	4.6	5.51	6.05	...	...
18	29.739	.652	.547	.6360	20.5	34.9	34.5	30.80	+ 7.37	.087	.178	.174	.151	.79	.88	.87	.85	N b E	E	E b N	N 82 E	5.0	10.0	3.0	5.18	5.91	0.040	...
19	.471	.255	.063	.2467	35.3	36.7	34.5	35.38	+11.85	.198	.205	.192	.198	.96	.94	.96	.96	E b s	N E	N N E	N 28 E	6.0	5.5	3.2	3 73	6.71	0.590	...
20	.113	.443	.797	.4888	36.0	28.0	20.8	26.28	+ 2.67	.172	.109	.097	.117	.81	.71	.87	.80	N N W	N w	W N w	N 38 W	16.5	23.0	14.2	18.38	19.10	...	Inp.
21	30.037	30.191	30.214	30.1570	5.0	10.4	6.0	7.50	—16.23	.049	.055	.049	.053	.90	.78	.85	.85	N	N	N b E	N 16 E	7.8	6.8	9.8	11.24	12.60	...	0.2
22	30.078	29.946	—	—	3.4	9.3	—	—	—	.045	.056	—	—	.90	.84	—	—	N E	E N E	N N E	N 43 E	21.0	16.0	6.5	12.53	12.94	...	0.2
23	30.066	30.073	29.973	30.0358	4.9	20.1	19.0	14.50	— 9.42	.045	.085	.098	.076	.80	.78	.95	.85	N b E	Calm.	N E	N 46 E	8.0	0.0	3.5	3.35	4.00	...	...
24	29.840	29.800	.845	29.8260	17.2	30.6	25.5	24.73	+ 0.60	.081	.144	.118	.112	.85	.85	.86	.83	N N E	s W b s	s w b w	s 53 w	4.2	5.0	7.0	4.91	5.84	...	...
25	.868	.813	.789	.8115	23.3	34.5	29.1	29.15	+ 4.82	.103	.149	.133	.130	.82	.75	.82	.80	W s W	s s W	s	s 18 E	3.3	9.8	2.2	1.62	4.98	Inp.	...
26	.562	.320	.238	.3722	32.4	34.9	36.7	35.18	+10.65	.169	.195	.213	.188	.91	.96	.98	.91	E N E	E b N	s E	N 89 E	12.0	9.8	4.0	2.22	8.67	0.060	...
27	.319	.534	.840	.5922	36.0	34.2	27.7	31.72	+ 7.00	.172	.131	.128	.137	.81	.66	.84	.76	s w b W	W	N W	N 76 W	8.4	26.0	6.0	11.89	13.26	...	Inp.
28	.942	.846	.642	.7897	24.8	30.9	29.1	28.22	+ 3.32	.112	.141	.133	.129	.84	.81	.82	.83	N b w	E s E	N E b E	N 69 E	2.4	7.0	9.0	7.58	8.28	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
M	29.8075	29 7830	29.7797	29.7922	19.46	25.62	22.37	22.41	— 1.26	.101	.114	.116	.110	.84	.78	.88	.83	....	......	.. .. ..	....	9.76	11.03	7.67	... ...	10.13	1.450	22.0

REMARKS ON TORONTO METEOROLOGICAL REGISTER FOR FEBRUARY, 1863.

Highest Barometer . . . . 30.502 at 11 a.m. on 4th. } Monthly range=
Lowest Barometer . . . . 29.037 at midnight on 19th. } 1.465 inches.
Self-registering Ther. { Maximum temperature . . . . 41°5 on p.m. of 26th } Monthly range=
Minimum temperature . . . . —19°8 on a.m. of 4th } 61°3
Mean maximum temperature . . 30°06 } Mean daily range=14°58
Mean minimum temperature . . 15°47 }
Greatest daily range . . . . . . 35°6 from a. m. of 4th to a. m. of 5th.
Least daily range . . . . 2°9 from a. m. to p. m. of 2nd.
Warmest day . . . 19th...Mean Temperature . . . 35°38 } Difference=39°90
Coldest day . . . . 4th ...Mean Temperature . . . —4°52 }
Maximum { Solar . . . . 55°6 on p.m. of 15th } Monthly range=
Radiation { Terrestrial . . . . —24°5 on a. m. of 4th } 80°.1

Aurora observed on 4 nights, viz., on 18th, 22nd, 23rd, and 25th; possible to see Aurora on 14 nights; impossible on 14 nights.

Snowing on 12 days; depth 22.0 inches; duration of fall 58.2 hours.

Raining on 7 days; depth, 1.450 inches; duration of fall, 40.7 hours.

Mean of cloudiness=0.66; below average, 0.05. Most cloudy hour observed, 2 p.m; mean=0.73; least cloudy hour observed, 10 p.m.; mean=0.60.

Sums of the components of the Atmospheric Current, expressed in Miles.

North.	South.	East.	West.
2527.34	1116.39	2185.40	2772.84

Resultant direction, N. 23° W.; Resultant Velocity, 2.27 miles per hour.
Mean velocity 10.13 miles per hour.
Maximum velocity 33.0 miles, from 10 to 11 a.m. on 20th.
Most windy day 20th—Mean velocity 19.10 miles per hour. } Difference 15.10
Least windy day 23rd—Mean velocity 4.00 miles per hour. }
Most windy hour, 10 to 11 a.m.—Mean velocity, 12.24 miles per hour. } Difference
Least windy hour, 9 to 10 p.m.—Mean velocity, 7.34 miles per hour. } 4.90 miles.

4th.—Very cold day; high barometric pressure; lunar halo and corona at 10 p.m. and midnight; rapid ascent of temperature.—5th. Great snow storm, and heavy drift from 10 a.m. of 5th to 10 a.m. of 6th.—9th. Stormy day, high wind: snow till 3.30 p.m.; sleet 3.30 to 4 p.m.; rain from 4 to 11 p.m.—11th. Solar halo during the forenoon.—18th. Solar halo 8 a.m.; auroral light 7 to 9 p.m.—19th. Dense fog 6 a.m. to 2 p.m.; raining from 3 p m. to 3 a.m. of 20th.—20th. Wind high and squally; rapid descent of temperature.—22nd. Auroral light, arches, and streamers, 9 to 11 p.m.—24th. Imperfect lunar halo at 9 30 p.m.—26th. Dense fog 5 to 10.30 p.m.; lunar halo at 11 p.m.—28th. Imperfect lunar halo at 10 p.m.

February, 1863, was comparatively cold, wet, windy and clear; it was also remarkable for rapid Barometric movements and great corresponding changes of temperature.

COMPARATIVE TABLE FOR FEBRUARY.

YEAR.	TEMPERATURE.					RAIN.		SNOW.		WIND.		
	Mean.	Excess above Average, (26°1).	Maximum observed.	Minimum observed.	Range.	No. of days.	Inches.	No. of days.	Inches.	Resultant. Direction.	Resultant. Velocity.	Mean Force or Velocity
1840	28.0	+ 5.0	49.1	— 8.3	57.4	8	1.475	6	...	...	...	...
1841	22.4	— 0.6	43.4	— 0.3	43.7	1	Inap.	9	...	...	...	0.61 lbs
1842	26.9	+ 3.9	48.7	+ 2.5	46.2	8	3.625	9	...	...	...	1.03 "
1843	14.5	— 8.5	37.5	—10.2	47.7	1	0.475	21	14.4	...	...	1.05 "
1844	26.0	+ 3.0	47.1	— 0.4	47.5	4	0.430	7	10.0	...	...	0.43 "
1845	26.0	+ 3.0	46.6	— 3.9	50.5	5	Imp	9	19.0	...	...	0.99 "
1846	20.4	— 2.6	41.4	—16.2	57.6	0	0.000	13	46.1	...	...	0.65 "
1847	21.5	— 1.5	42.2	— 1.0	43.2	2	0.550	13	27.3	...	...	0.69 "
1848	26.6	+ 3.6	46.9	— 0.6	47.5	4	0.775	8	10.8	N 65 W	2.53	5.69ms
1849	19.5	— 3.5	41.1	— 9.2	50.3	2	0.240	13	19.2	N 41 W	1.48	6.58 "
1850	26.0	+ 3.0	49.2	+ 1.3	47.9	7	1.235	9	23.1	N 80 W	3.43	7.61 "
1851	27.6	+ 4.6	50.2	+ 1.3	48.9	7	2.600	4	2.4	N 64 W	1.99	6.94 "
1852	23.4	+ 0.4	41.2	— 3.2	44.4	3	0.650	11	13.0	S 75 W	3.34	6.42 "
1853	24.1	+ 1.1	43.4	— 0.6	44.0	4	1.030	15	12.6	N 49 W	2.51	7.30 "
1854	21.1	— 1.9	42.7	— 5.7	48.4	5	1.460	15	18.0	N 7 E	1.73	6.91 "
1855	15.4	— 7.6	37.3	—25.0	62.3	2	1.770	14	21.8	N 40 W	4.34	8.17 "
1856	15.7	— 7.3	35.3	—18.7	54.0	0	0.000	8	9.7	N 81 W	7.70	10.71 "
1857	28.5	+ 5.5	51.2	— 5.9	57.1	11	3.050	11	11.7	S 78 W	3.68	9.82 "
1858	17.0	— 6.0	40.9	— 6.6	47.5	1	Inap	16	26.7	N 72 W	3.22	9.12 "
1859	26.0	+ 3.0	43.3	+ 3.9	39.4	6	0.455	14	8.3	N 54 W	2.72	8.50 "
1860	22.8	— 0.2	48.1	— 8.4	56.5	7	1.330	13	18.8	N 61 W	3.28	8.73 "
1861	26.1	+ 3.1	44.6	—20.4	65.0	4	0.815	17	29.7	N 77 W	3.86	10.58 "
1862	22.5	— 0.5	35.6	— 3.7	39.3	3	0.180	17	23.1	N 55 W	3.93	8.52 "
1863	22.4	— 0.6	38.9	—19.8	58.7	7	1.450	12	22.0	N 23 W	2.27	10.13 "
Results to 1861.	22.98	...	44.15	—6.16	50.32	4.2	1.046	11.6	18.03	N 69 W	3.02	8.08
Exc. for 1863.	—0.57	...	— 5.25	— 13.64	+ 8.38	+ 2.8	+ 0.404	+ 0.4	+ 3.97	...	...	+2.05

MONTHLY METEOROLOGICAL REGISTER, AT THE PROVINCIAL MAGNETICAL OBSERVATORY, TORONTO, CANADA WEST.—MARCH, 1863.

Latitude—43 deg. 39.4 min. North. Longitude—5 h. 17 min. 33 sec. West. Elevation above Lake Ontario, 108 feet.

Day.	Barom. at temp. of 32°.				Temp. of the Air.				Excess of mean above Normal.	Tens. of Vapour.				Humidity of Air.				Direction of Wind.			Resultant Direction.	Velocity of Wind.					Rain in Inches	Snow in Inches.
	6 A.M.	2 P.M.	10 P.M.	MEAN.	6 A.M	2 P.M.	10 P.M	ME'N		6 A.M	2 P.M.	10 P.M.	M'N	6 A.M	2 P.M.	10 P.M.	M'N	6 A.M.	2 P.M.	10 P. M		6 A.M	2 P.M	10 P.M	Re-sul't	ME'N		
					°	°	°	°	°												°							
1	29.305	29.216	—	—	29.8	31.3	—	—	—	.154	.152	—	—	.93	.86	—	—	N E	N N W	W S W	N 10 W	13.0	11.0	1.5	3.97	7.10	...	1.5
2	.435	.466	29.469	29.4740	30.6	36.5	31.3	32.35	+ 6.93	.152	.174	.166	.160	.89	.80	.95	.88	S W	S W b S	E	S 63 E	0.5	3.2	2.0	0.78	5.07	...	2.0
3	.506	.564	.700	.5988	22.3	23.3	14.0	19.43	— 6.28	.107	.096	.068	.089	.89	.76	.82	.83	N E b N	N b W	N W	N 22 W	7.0	8.2	15.5	9.35	10.15	..	1.5
4	.847	.957	30.051	.9565	—1.2	14.3	6.0	7.05	—18.95	.039	.052	.013	.043	.94	.63	.75	.74	N W	N W b W	Calm.	N 38 W	5.5	12.0	0.0	4.61	4.77	...	...
5	30.030	.919	29.545	.8120	—3.4	24.1	29.8	18.78	— 7.42	.030	.107	.109	.089	.84	.82	.66	.78	Calm.	S S W	S b W	S 24 W	0.0	12.0	13.0	11.23	11.44	...	0.2
6	29.255	.416	.676	.4683	34.5	38.5	26.6	32.67	— 6.17	.166	.123	.112	.132	.83	.52	.77	.71	S W	W b N	W N W	N 81 W	18.0	21.2	2.0	10.24	11.99	...	...
7	.715	.639	.662	.6637	21.9	21.5	21.5	21.62	— 5.20	.105	.102	.102	.102	.89	.88	.88	.88	N E b N	N E b E	E N E	N 48 E	1.5	9.0	8.0	9.16	9.41	...	1.5
8	.426	.383	—	—	17.6	24.4	—	—	—	.083	.096	—	—	.85	.73	—	—	N E b N	Calm.	S W b S	S 50 W	12.0	0.0	6.0	1.38	5.24	...	0.2
9	.321	.525	.688	.5422	28.8	28.0	26.6	26.82	— 0.70	.129	.082	.091	.100	.81	.53	.62	.68	W	W S W	SW bW	S 75 W	18.0	23.0	11.0	14.60	14.97	...	...
10	.771	.627	.474	.6128	16.1	34.2	29.8	27.48	— 0.33	.074	.146	.133	.119	.83	.75	.80	.77	W N W	S S W	SW bW	S 29 W	0.8	6.5	3.5	5.33	5.60	...	...
11	.403	.454	.624	.5023	26.9	27.7	17.6	23.77	— 4.47	.131	.092	.076	.096	.89	.60	.79	.75	W	N N W	W b N	N 31 W	0.5	17.0	2.0	8.70	8.94	...	...
12	.667	.728	.796	.7372	13.6	19.0	10.7	13.90	—14.65	.072	.060	.059	.063	.90	.57	.82	.77	W N W	W N W	N b W	N 36 W	6.0	12.2	0.5	6.40	6.69	...	...
13	.771	.719	.734	.7383	8.9	19.4	16.5	15.18	—13.78	.055	.030	.064	.065	.84	.76	.68	.74	N b E	N b W	W S W	N 68 W	0.5	9.5	9.5	5.98	7.17	...	0.2
14	.639	.514	.639	.6003	17.2	29.5	21.5	22.73	— 6.58	.075	.121	.069	.087	.78	.74	.59	.70	W b S	W S W	N N E	N 55 W	6.0	15.0	8.5	3.99	10.95	...	...
15	.751	.694	—	—	4.9	20.1	—	—	—	039	.073	—	—	.71	.66	—	—	N E	E b N	N N E	N 45 E	11.5	17.2	11.0	11.87	12.33	...	0.2
16	.745	.790	.747	.7647	14.3	28.7	28.0	23.57	— 6.47	.035	.109	.117	.095	.78	.69	.76	.73	N	S S W	S W	N 86 W	7.0	3.8	2.5	0.91	3.33	...	0.2
17	.699	.548	.688	.6475	26.6	37.4	34.9	33.38	+ 2.93	.133	.170	.159	.153	.95	.76	.78	.80	S W b S	Calm.	N	N 7 W	0.5	0.0	6.8	4.12	6.92	...	...
18	.852	.982	30.069	.9873	18.7	23.7	15.8	19.20	—11.65	.070	.049	.078	.066	.68	.39	.88	.65	N b E	N	N b W	N 2 W	10.0	8.5	10.0	8.01	8.15	...	..
19	30.137	30.147	30.149	30.1450	11.1	24.1	19.7	18.78	—12.48	060	.065	.090	.073	.83	.49	.84	.72	N b E	E b S	N N E	N 54 E	4.5	3.2	2.2	3.25	4.05	...	...
20	30.157	30.177	30.103	30.1433	21.5	25.5	26.6	25.02	— 6.65	.095	.083	.091	.090	.82	.60	.62	.66	N E b E	E	E b S	S 83 E	5.5	17.8	18.0	15.62	15.72	...	...
21	29.943	29.797	29.773	29.8330	27.7	29.1	33.1	30.02	— 2.07	.142	.155	.182	.160	.94	.96	.97	.96	E S E	E b S	S S W	S 54 E	14.5	10.5	3.8	6.24	6.99	0.030	3.0
22	.798	.805	—	—	32.4	39.2	—	—	—	.169	.199	—	—	.91	.83	—	—	Calm.	E b S	E	N 87 E	0.0	2.0	3.5	3.15	3.39	...	...
23	.790	.712	.675	.7268	34.2	35.2	34.9	34.40	+ 1.62	.152	.139	.177	.158	.77	.68	.86	.79	E b N	E b N	E b N	N 80 E	14.0	20.5	14.8	16.06	16.07	0.102	0.1
24	.509	.319	.312	.3712	36.7	39.2	41.4	38.25	+ 5.08	.205	.233	.232	.217	.94	.97	.89	.93	E	E b N	S	N 86 E	11.0	12.2	10.2	7.15	10.71	0.315	...
25	.215	.150	.324	.2237	36.3	38.5	33.4	36.18	+ 2.62	.210	.208	.171	.199	.98	.89	.89	.93	N N E	W N W	W S W	N 65 W	9.5	15.0	5.0	6.35	8.88	0.240	0.2
26	.359	.426	.642	.4898	31.3	34.9	29.5	31.53	— 2.45	.166	.144	.129	.143	.94	.71	.78	.80	W S W	W	N W b W	N 73 W	3.5	12.0	14.6	9.17	10.20	...	0.1
27	.752	.732	.695	.7287	28.0	37.4	30.9	32.10	— 2.32	.131	.137	.120	.129	.86	.61	.69	.72	W b S	S b W	S	S 35 W	6.2	3.0	1.8	2.80	5.24	...	0.1
28	.477	.270	.296	.3380	27.7	36.7	26.2	30.55	— 4.17	.135	.171	.110	.142	.89	.78	.77	.82	N E b N	E b N	N W	N 38 W	5.5	7.0	26.0	8.44	13.75	...	0.3
29	.405	.511	—	—	18.6	32.7	—	—	—	.090	.135	—	—	.89	.73	—	—	W N W	N W b W	W N W	N 53 W	21.8	28.0	21.0	20.27	21.10	...	Inp.
30	.899	.836	.718	.8073	21.2	36.0	30.2	29.23	— 6.27	.092	.126	.136	.120	.81	.59	.80	.75	N W	S b W	S	S 8 W	4.5	7.0	4.5	3.88	5.31	...	...
31	.478	.282	.352	.3642	25.5	39.9	19.7	27.95	— 7.97	.125	.182	.090	.127	.91	.73	.84	.80	N E b N	S b W	N N W	N 24 W	5.8	3.5	40.0	13.80	15.62	...	0.1
M	29.6693	29.6422	29.6770	29.6649	22.19	30.09	25.24	25.84	— 4.54	.112	.123	.114	.116	.86	.70	.79	.78	......	......	......	......	7.25	10.68	8.93	......	9.27	0.687	11.4

REMARKS ON TORONTO METEOROLOGICAL REGISTER FOR MARCH, 1863.

Highest Barometer........................ 30.180 at 8 a. m. on 20th } Monthly range =
Lowest Barometer .... 29.129 at 8 a. m. on 25th } 1.051 inches.

Self-registing Thermom.
Maximum Temperature .... 42°2 on p.m. of 31st } Monthly range=
Minimum Temperature .... —4°0 on a.m. of 5th } 46°2
Mean maximum Temperature .... 32°81 } Mean daily range=
Mean minimum Temperature .... 19°42 } 13°39
Greatest daily range ...... 39°6 from a.m. of 5th to a.m. of 6th.
Least daily range............ 4°3 from a.m. to p.m. of 3rd.

Warmest day......... 24th... Mean temperature......... 38°25 } Difference = 31°20.
Coldest day .... 4th... Mean temperature......... 7°05 }
Maximum } Solar.......................................65°5 on p.m. of 6th } Monthly range =
Radiation. } Terrestrial.............................—14°5 on a.m. of 5th } 80°0
Aurora observed on 5 nights, viz.,—12th, 20th, 25th, 29th, and 30th.
Possible to see Aurora on 18 nights; impossible on 13 nights.
Snowing on 17 days, depth 11.4 inches; duration of fall, 71.3 hours.
Raining on 4 days, depth 0.687 inches; duration of fall 26.1 hours.
Mean of cloudiness = 0.63. Above average 0.04.
Most cloudy hour observed, 2 p.m: mean = 0.71; least cloudy hour observed, 10 p.m.; mean, = 0.50.

Sums of the components of the Atmospheric Current, expressed in miles.

North.	South.	East.	West.
2862.57	1127.49	1917.34	2800.70

Resultant direction N. 27° W.; Resultant velocity 2.62 miles per hour.
Mean velocity ....9.27 miles per hour.
Maximum velocity .... 40.0 miles, from 9.30 to 10.30 p.m.
Most windy day ......29th............Mean velocity, 21.10 miles per hour. } Difference=
Least windy day......16th............Mean velocity, 3.33 ditto. } 17.77 miles.
Most windy hour ...1 p.m. to 2 p.m..........Mean velocity, 11.65 ditto. } Difference=
Least windy hour...2 a.m. to 3 a.m. ....Mean velocity 7.18 ditto. } 4.47 miles.

4th. Very cold day, clear and keen.—6th. Lunar halo from 11 p.m.—8th. Solar halo at 4 p.m.—12th. Solar halo at 7 a.m.; auroral light at midnight.—14th. Solar halo at 9 and 10 a.m.—20th. Solar halo 7 and 8 a.m.; auroral light at midnight.—21st. Fog at midnight.—22nd. Fog at 6 a.m.—25th. Auroral light at 7.50 p.m.—27th. Lunar halo at 7.30 p.m.—28th. Solar halo at 7 and 8 a.m.—29th. Auroral light and bright streamers from 10 p.m.—30th. Lunar halo 9 p.m. to midnight; faint auroral light at 10 p.m. and midnight.—31st. Cold stormy night; wind high and in violent squalls.

March, 1363, was comparatively cold, dry, windy and cloudy,

COMPARATIVE TABLE FOR MARCH.

YEAR.	TEMPERATURE.					RAIN.		SNOW.		WIND.		
	Mean.	Excess above aver'ge (30.1)	Max. ob-served.	Min. ob-served.	Range.	No. of days.	Inches	No. of days.	Inches	Resultant. Direction.	Resultant. V'y.	Mean Force or Velocity.
1840	33.3	+ 3.2	56.9	8.7	48.2	8	1.640	8	...	...	...	....
1841	27.7	— 2.4	53 5	— 6 9	60.4	5	1.170	7	...	...	...	0.51 lbs.
1842	35.8	+ 5.7	68.7	14.9	53.8	4	3.150	8	...	...	...	0.70
1843	21.3	— 8.8	38.6	— 2.8	41.4	2	0.625	18	25.7	...	...	1.18
1844	31.3	+ 1.2	50.3	9.6	40.7	8	2.470	8	14.0	...	...	0.57
1845	35.4	+ 5.3	61.7	9.9	51.8	5	Imp	8	2.8	...	...	0.66
1846	33.1	+ 3.0	49.3	7.6	41.7	9	1.965	5	2.3	...	...	0.30
1847	26.2	— 3.9	44.3	4.8	39.5	5	0.850	6	4.2	...	...	0.71
1848	28.6	— 1.5	58.9	0.9	58.0	5	1.220	6	9.7	N 66° W	2.03	5.80mls.
1849	33.5	+ 3.4	53.4	15.4	38.0	7	1.525	2	2.3	N 3° W	1.48	5.37
1850	29.8	— 0.3	46.0	6.0	40.0	2	0.745	7	11.2	N 52° W	2.62	7.62
1851	32.4	+ 2.3	58.7	13.1	45.6	3	0.770	9	8.8	N 21° W	1.93	7.65
1852	27.7	— 2.4	44.8	— 3.2	48.0	8	3.080	12	19.5	N 8° W	0.71	5.81
1853	30.6	+ 0.5	56.3	— 0.1	56.4	6	1.080	8	7.1	N 58° W	2.60	5.96
1854	30.7	+ 0.6	52.8	10.4	42.4	9	2.425	3	2.8	N 53° W	3.39	8.03
1855	28.5	— 1.6	48.6	— 2.9	51.5	5	1.485	11	18.1	N 88° W	4.76	9.95
1856	23.1	— 7.0	39.3	—13.6	52.9	0	0.000	12	16.2	N 71° W	7.68	11.39
1857	27.8	— 2.3	56.5	— 3.9	60.4	4	0.335	15	11.3	N 63° W	6.63	10.84
1858	28.4	— 1.7	54.1	— 5.5	59.6	10	0.917	6	0.2	N 58° W	5.45	8.56
1859	36.3	+ 6.2	53.7	10.4	43.3	15	4.054	8	1.0	N 64° W	1.96	10.39
1860	34.5	+ 4.4	66.4	14.2	52.2	5	0.882	11	2.4	N 64° W	7.61	12.41
1861	26.9	— 3.2	43.2	— 4.1	47.3	8	2.125	14	7.1	N 54° W	4.33	10.56
1862	28.8	— 1.3	41.4	9.3	32.1	8	2.560	11	18.5	N 12° W	2.50	9.38
1863	25.8	— 4.3	41.4	— 3.4	44.8	4	0.687	17	11.4	N 27° W	2.62	9.27
Results to 1861.	30.13	...	52.55	3.77	48.78	6.0	1.548	8.7	8.77	N 60° W	3.63	8.60
Exc. for 1863.	— 4.29	...	— 11.15	—7.17	— 3.98	— 2.0	— 0.861	+ 8.3	+ 2 63	....	......	+ 0.67

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THE CANADIAN JOURNAL.

NEW SERIES.

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REMARKS ON THE NEGATIVE INDEX OF A FUNCTION.

BY THE REV. E. K. KENDALL,
LATE PROFESSOR OF MATHEMATICS IN TRINITY COLLEGE, TORONTO.

In the consideration of indices, whether used to denote powers of numerical or algebraical expressions, or the successive performance of some operation or function on a quantity, it is usual in examining the meaning of negative or fractional indices to state that *it is convenient* to assign certain interpretations, because of a certain generality which then obtains in the results. In the words of a recent author,* "Experience will prove that the notation here given is often convenient, and we may shew that it is not altogether an *arbitrary* notation but one that naturally presents itself." It appears to me that this, at any rate in the case of negative indices, is an inadequate mode of expressing the ground on which these indices are interpreted, and that the meaning to be assigned to the index is not only one that *naturally presents itself*, not only *not altogether arbitrary*, but *the* meaning which *must* be assigned, exclusive of any other meaning, and no more arbitrary than the use of the notation for positive integral indices. With respect to fractional indices even, I am of opinion that the above would be an insufficient account of the reasons by which we are led to accept an interpretation of the index since it would leave an impression that we are guided rather by what is *convenient* than by what is true, and that perhaps some other more convenient explanation might some day replace the one now adopted. But in the case of the negative index such a mode of expression is still less admissible, because the steps by which the meaning is established are so easy and straightforward.

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* See Todhunter's "Plane Trigonometry."

If any operation performed on a quantity x be denoted by $f^1(x)$, we should denote the same operation performed upon $f^1(x)$ by $f^1(f^1(x))$ or conveniently by $f^2(x)$. $f^2(x)$, therefore, denotes the operation f^1 performed *once* upon $f^1(x)$, or *twice* successively on x. Similarly $f^3(x)$ may be used to denote the function f^1 performed *once* on $f^2(x)$, *twice* successively on $f^1(x)$, or *three times* successively on x, and so on. Adopting this notation we shall have $f^m(x)$ to represent the operation f^1 performed m times on x successively, and $f^{m+n}(x)$ or $f^{n+m}(x)$ to represent either the performance of the operation f^1 m times on $f^n(x)$, *i.e.*, $=f^m(f^n(x))$ or n times on $f^m(x)=f^n(f^m(x))$ or $m+n$ times on x, the result being in each case the same, *i.e.*,

$$f^{m+n}(x)=f^n(f^m(x)) \qquad (\alpha)$$
$$=f^m(f_n(x)) \qquad (\beta)$$

Hence $f^m(x)$ is derivable from $f^{n+m}(x)$ by *undoing* the n operations denoted by f^n in (α) and $f^m(x)=f^{\overline{m+n}-n}(x)$.

Hence $-n$ in the index must be regarded as undoing the operation f^1 *n times* supposing it had been performed *more than n times* on x.

But what does $f^0(x)$ or $f^{-n}(x)$ represent of itself, when there is no operation to undo?

Now we observe that f^1 denotes an operation performed *once,* f^2 *twice;* f^m *m times.*

$\therefore f^0$ represents the operation performed *no* times, that is, *not performed at all,* or $f^0(x)$ is the same as x, for just as truly as f^m represents m operations, so truly does f^0 represent no operations:

one is as general as the other. Hence we can assign the meaning of the negative index, for f^{-1} means the reverse operation to f^1; if both f^1 and f^{-1} be performed on x, one undoes what the other does, and the result is x. So that $f^{-1}(x)$ represents that quantity or quantities, for there may be more than one, on which if you perform the function denoted by f^1 the result is x. And so f^{-2} denotes that quantity or quantities on which if you perform the function f^1 *twice* the result is x. It will not be possible in every case to assign a numerical or even symbolical expression of every inverse function that may occur, but it appears to me that the *meaning* of the notation is perfectly definite, and that it ought to be treated as such. The theory of indices stands on very different grounds from any arbitrary convenient explanation of, for instance, the symbol $\sqrt{-1}$, derived from the truth of results obtained by treating it as a real quantity. It may, however, be as well in conclusion to notice one or two obvious cases to which the above remarks are applicable:

(1). Theory of Indices in multiplication or division of like quantities in arithmetical algebra,—

$$\text{Here } a^m = a \times a \times a \text{ to } m \text{ factors.}$$

Now a denotes an operation performed on unity, namely, multiplying it by a. Hence a replaces f^1 and 1 replaces x, 1 being usually for simplicity omitted. Thus $a^0 = a^0 (1) = 1$.

a^{-1} = a quantity which, multiplied by a, will = 1, *i.e.*, $= \frac{1}{a}$.

a^{-2} = a quantity which, multiplied twice by a, will give 1, *i.e.*, $= \frac{1}{a^2}$, and so on.

Unity is here abstract or concrete, and the result abstract or concrete accordingly. In the few cases in which an interpretation may with more or less strictness be applied to the multiplication or division by one another of concrete magnitudes, the unit will of course be of that denomination which is denoted by the index after such multiplication or division.

(2). Indices denoting Trigonometrical Functions, for example,—

Sin $^0 (x)$ means x.

Sin (x) " the sine of x.

Sin$^{-1} (x)$ " that angle of which the sine is x.

Sin $^2 (x)$ " the sine of the sine of x, and so on.

N.B.—These must carefully be distinguished from $(\sin x)^2$, $(\sin x)^{-1}$, $(\sin x)^0$, which come under the former or following head, and are frequently, though inaccurately, written as above.

(3). Indices denoting any function whatever,—

Example (1): Let $f^1(x)$ be the differential of $x = dx$, $f^0(x)$ is x, $f^{-1}(x)$ is $d^{-1}(x)$ meaning that which, if differentiated, will give x—in other words the integral of x. $f^{-2}(x)$ is $d^{-2}x$ that which, if differentiated *twice*, will give x, or the *second* integral of x, and so on.

It will be observed that this illustration shews clearly that a definite meaning is attached to the inverse symbol, for although our analysis may not be sufficient to enable us, in any special case, to integrate the required number of times, yet the operation is not only *conceivable* but never beyond the bounds of *possibility*, and may be *practicable*, and, what is more, may in every case be performed independently of our knowledge of the results of differentiation.

Example (2): Let $f(x) = x + \frac{1}{x}$

$$f^0 x = x$$

$$f^{-1}(x) = \frac{x}{2} \pm \frac{\sqrt{x^2 - 4}}{2}$$

For performing the function f on this we get,—

$$\frac{x \pm \sqrt{x^2 - 4}}{2} + \frac{2}{x \pm \sqrt{x^2 - 4}} = \frac{2x^2 - 4 + 2x\sqrt{x^2 - 4}}{2(x \pm \sqrt{x^2 - 4})} + \frac{4}{2(x \pm \sqrt{x^2 - 4})}$$

$$= \frac{2x}{2} = x$$

And similarly,

$$f^{-2}(x) = \frac{x \pm \sqrt{x^2 - 4} \pm \sqrt{2(x^2 - 10 \pm \sqrt{x^2 - 4})}}{4}$$

which may be verified. Beyond this point, the analysis fails to give the inverse function, though equations may be found to determine them. To take one more example,—

$$f(x) = \sqrt{a + x}$$

$$f^0(x) = x$$

$$f^2(x) = \sqrt{a + \sqrt{a + x}}$$

$$f^{-1}(x) = x^2 - a$$

$$\text{for } f^1 f^{-1}(x) = \sqrt{a + x^2 - a} = \sqrt{x^2} = x$$

$$f^{-2}(x) = (x^2 - a)^2 - a$$

$$\dots = \dots\dots$$

$$f^{-n}(x) = \Big\{ \dots \Big\{ \big\{ (x^2 - a)^2 - a \big\}^2 - a \Big\}^2 - a \Big\} \dots\dots \Big\}$$

to n brackets.

Note:—Since writing the above, the invaluable treatise of Professor Boole on Differential Equations has been published. In his XVIth chapter there are a few remarks on *inverse forms,* which seem to bear out what has been said on their proper interpretation. He writes, commenting on the index laws as applied to functions: "All that is said above relates to the performance of operations definite in character upon subjects proposed to be given. But an inverse problem is suggested in which it is required to determine, not what will be the result of performing a certain operation upon a given subject, but *upon what subject a certain operation must be performed in order to lead to a given result.*" So below he adds: "If π represent any operation or series of operations possible when their subject is given, and then termed *direct,* and if in the equation $\pi u = v$ the subject u be not given but only the result $= v$ then we may write $u = \pi^{-1} v$. And the problem or enquiry contained in the inverse notation will be answered when we have, by whatever process, so determined the function u as to sstisfy $\pi u = v$ or $\pi \pi^{-1} v = v$. By the latter equation the inverse symbol π^{-1} is defined. Thus it is the *office* of the inverse symbol to propose a *question,* not to describe an operation."

If the inverse symbol has an *office,* it is obviously more than a mere convenient notation. The *form* of the above statement may perhaps be open to objection, since when two precisely reverse operations are performed it seems as fair to denote one of them a question as the other. But the view taken of the inverse symbol is the same, whatever be thought of the propriety of this statement.

REMARKS ON SOME GENERAL PROPERTIES OF CURVES.

BY J. W. MARTIN, LL.D.

The geometric method of investigation, so highly esteemed by Newton and his followers, has experienced considerable vicissitude as regards the amount of attention bestowed upon it by mathematicians at different periods. Having for more than a century held undisputed sway in the universities of Great Britain, it was at length obliged to yield to those more powerful methods of investigation, which, prosecuted with untiring zeal and ingenuity by men possessing unrivalled powers of analysis, had placed the continental mathematicians so far in advance of those in England. Though for a time decried as much as it was before injudiciously extolled, the geometric method has never been utterly neglected. It possesses merits of its own that must ever claim the attention of men of science. It affords solutions of many questions far more concise than can be furnished by the analyst, and occasionally presents us with theorems which, as beautiful as unexpected, shew that its powers have not even yet been developed to the utmost.

1. If two curves lie, the one inside the other, and a right line be drawn cutting the curves so that the sum of the areas of the segments cut off shall be constant, the envelop of the right line is the locus of the centre of gravity of the sum of the chords.

2. Similarly, if the difference of areas is constant the envelop of line is locus of centre of gravity of difference of chords, that is of the portions of the right line enclosed between the two curves.

These theorems have been slightly altered in form so as to exhibit more strongly an analogy to a theorem given by Professor Cherriman, in the *Canadian Journal*, February, 1863.

3. The envelop of chords cutting a curve at equal angles is locus of a point dividing these chords, so that rectangle under segments is constant.

4. The envelop of chords joining points of taction of parallel tangents is locus of a point dividing those chords in a given ratio.

If the curve is a central conic the envelop is a point, the centre of conic.

5. If the curves S and S' are so related that tangent at any point

P in S cuts the curve S' at a constant angle in P', tangent to evolute of S makes with evolute of S' a constant angle.

6. If S and S' intersect in the point O, the arc OP' bears a constant ratio to the difference between the arc OP and the tangent PP'.

The logarithmic spiral will serve to illustrate the two last theorems.

7. If right lines drawn from any point R in the curve S to touch the curves S' and S'' in the points P and Q are equal, the product of the tangents of the halves of the angles which the lines RP, RQ make with the tangent to S at the point R is constant.

As particular examples of this theorem we may take, firstly, the case of tangents drawn to a circle from any point in a line given in position.

Secondly, tangents drawn to two given circles from any point in their radical axis.

8. In the same figure as the last, if instead of having the tangents equal we have the angle PRQ constant, the circle passing through the three points P, R, Q, touches the curve S at the point R, and the normals to the three curves at the points P, R, Q, meet in a point.

9. If right lines drawn from any point R in the curve S touching the curve S' in the points P and Q contain with the arc PQ a constant area, tangent at R is parallel to the right line joining P and Q.

10. If the vertex of a constant angle is at the point O, and the sides of the angle cut the curve S in the points P and Q, and the curve S' in P' and Q', area of the figure $PQ\,P'Q'$ is a maximum when difference of squares of OP and OP' is equal the difference of squares of OQ and OQ'.

Hence if from a point O outside a circle it is required to draw two secants containing a given angle, so that the area of the figure contained by the secants and the circumference of the circle may be a maximum, it is when the secants make equal angles with the diameter passing through the point O.

11. If the vertex of a constant angle is at the point O, and the sides of the angle cut the curve S in P and Q, the sum of OP and OQ is a minimum when the ratio of OP to OQ is equal to the ratio of the tangents of the angles which the sides of the given angle make with the curve.

REMARKS ON THE TEMPERATURE COEFFICIENTS OF MAGNETS.

BY G. T. KINGSTON, M.A.
DIRECTOR OF THE PROVINCIAL MAGNETIC OBSERVATORY, TORONTO.

It has been long a matter of notoriety, that the correction to the scale-reading of a force magnetometer which is due to a change of one degree in its temperature, and which is derived from a comparison of the changes in its scale-readings with those of the attached thermometer, is often greatly at variance with $\left(\frac{q}{k}\right)$, the value of the correction in which q is the temperature coefficient of the magnet found by the ordinary hot and cold water experiments, and k the scale coefficient. The discrepancy has been attributed to the action of changes of temperature on the supports and appendages of the magnet when in adjustment, independent of, and in addition to, the alteration that such changes effect in the magnetic moment of the magnet; and as these effects cannot be determined *a priori*, it is safer, instead of relying on the experiments, to adopt the practice now almost general, of deriving the temperature corrections from the recorded observations with the instrument and its thermometer, either by grouping them in seasons, as explained in page ii. of the Introduction to the third volume of the *Toronto Observations*, or by comparing groups of scale-readings at intervals of a few days, as in pp. xxiii. and xxiv. of the same volume.

Since, however, the first of these methods requires an unbroken series of two or more years, and the second a series of a year in length at least, it may be worthy of consideration whether the method of obtaining the correction from the temperature experiments cannot be made to yield results in sufficient accordance with the truth to serve the purpose of provisional reduction, or to meet the case in which the bifilar is needed as an auxiliary instrument to aid in the reduction of the absolute determination of the horizontal force, where since the range of temperature during the observations is small, the effect of a small error in the correction to the bifilar readings will be of less moment.

Let (m) be the magnetic moment of the magnet whose temperature coefficient (q) is sought, and which is placed as a deflector with its axis at right angles to that of the suspended magnet in its deflected position, the axes of the two magnets being in the same horizontal plane, and the centre of the unifilar in the prolongation of the axis of the deflector.

Also let r be the distance between the magnetic centres,
u the angle of deflection,
X the horizontal component of the force.

The relation between m, r, u, and X is given by the formula

$$m = f(r)\,\mathrm{X}\sin u, \text{ (where } f(r) \text{ is some function of } r\text{)}$$

and that of their simultaneous small changes by

$$\frac{\Delta m}{m} = \frac{f'(r)}{f(r)}\,\Delta r + \cot u\,\Delta u + \frac{\Delta \mathrm{X}}{\mathrm{X}}$$

Now, if $\frac{\Delta m}{m}$ be the increase in the magnetic moment due to a decrease of $(t - t_0)$ in the temperature, and q that due to a decrease of 1°, so that $\frac{\Delta m}{m} = q\,(t - t_0)$, the preceding equation will become

$$q = \frac{1}{t - t_0}\left\{\frac{f'(r)}{fr}\,\Delta r + \cot u\,\Delta u + \frac{\Delta \mathrm{X}}{\mathrm{X}}\right\}.$$

It is customary to assume that $\Delta r = 0$, or that the magnetic centre occupies a fixed position in the magnet during the changes of temperature. Such will probably be the case if the magnet be strictly homogeneous throughout ; but if its molecular condition be not uniform, it is at least conceivable that a change of temperature will affect differently the different parts of the magnet, as it is already known to affect the general magnetism of two different magnets.

Suppose, then, the north end of the deflector to be directed towards the suspended magnet, and that a decrease of 1° in temperature causes the magnetic centre to recede from the north end by the small quantity (a), so that $\Delta r = (t - t_0)a$. Also, suppose q_1 to be the value of q determined in this case on the supposition that r is constant or that $\Delta r = 0$.

We shall then have

$$q = \frac{f'(r)}{f(r)}\,a + q_1$$

Similarly, if q_2 be the value determined on the same hypothesis when the south end of the deflector is presented,

$$q = -\frac{f'(r)}{f(r)}a + q_2,$$

Whence $$q = \tfrac{1}{2}\left\{ q_1 + q_2 \right\},$$

or the temperature coefficient q will be the arithmetic mean between q_1 and q_2, the values derived from the experiments in which the North and South Poles respectively are presented.

The probability that an alteration in the distribution of magnetism does sometimes accompany a change in the temperature of a magnet, was suggested by the results of temperature experiments made by me in March, 1861, on two magnets in use at the Toronto Observatory. With one of these—the magnet of our small bifilar—the results were as follows:

North pole presented .... $q_1 = 0000603$;
South " .... $q_2 = 0001105$;
Giving .... $q = 0000854$;
But the scale coefficient .... $k = 000115$;
Whence .... $\frac{q}{k} = 0 \cdot 74$ nearly.

But from the observations in the period to which the foregoing value of k belongs, and by the method on pp. xxiii. and xxiv. of the Introduction to the third volume of the *Toronto Observations,* the equivalent in scale divisions for a change of one degree of temperature, was 0·66 nearly, a result with which the above value of $\frac{q}{k}$ shews a very tolerable accordance.

The value of $q_2 = 0001105$, which is given above, agrees very fairly with the results of a series of experiments in 1843 and another in 1845, which gave respectively $q = 0001032$ and $q = 0001138$.

Again, in page xxvii. of the third volume of the *Toronto Observations,* we find that by experiments in 1843–44, on the magnet of Lloyd's Vertical Force Magnetometer,

$$q = 000112;$$

and by experiments in 1846,

$$q = 00007.$$

But in March, 1861, when the North Pole of this magnet was presented, I found the partial value of the temperature coefficient to be

$$q_1 = 000106;$$

and when the South Pole was presented,

$$q_2 = 000067;$$

giving $q = 000086$ nearly as the true temperature coefficient.

The remarkable accordance of q_1, q_2, with the results of the two earlier experiments, makes it very probable that the North Pole was presented in the experiments of 1843–44, and the South Pole in those of 1846. Should such be the case, the true value of q during that period would have been 00009 nearly. But it is shewn on the same page, that by the multiplication of the equivalent to a degree of temperature by k the scale coefficient, there is obtained

$$q = 0001105,$$

which agrees much better with $q = 000112$, the value derived from the experiments of 1843–44, than it does with $q = 00009$; from which it would appear that the error that would be committed by taking $q = 000112$, and which is caused by a change in the distribution of the magnetism, would be almost completely compensated by the superposed effects of temperature on the instrument.

The discordance above referred to between the results of temperature experiments in which the two poles are successively presented, may be an exceptional property. Of eight magnets tested at my suggestion, by Mr. Stewart, of the Observatory at Kew, through the kind intervention of General Sabine, one only showed any material difference in the results derived from presenting both poles; and for other magnets that I have tried, results materially the same have been obtained, whichever pole was presented; nevertheless, the fact that it has been occasionally otherwise is a sufficient motive, I think, in conducting temperature experiments to present each pole of the deflector instead of one only.

NOTE ON POINSOT'S MEMOIR ON ROTATION.

BY J. B. CHERRIMAN, M.A.
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This celebrated memoir of Poinsot's, which, in connection with his invention of couples, has revolutionised our whole system of mechanics, treats the subject partly in an analytical, partly in a geometrical manner. In our modern text books the analytical method is mainly adopted, and it has seemed to me that the beauty and simplicity of the system have thereby been much overlooked. In following, and possibly simplifying by a more elementary geometry, Poinsot's course, we commence with the general reduction of a set of statical forces to a single resultant force and a single resultant couple.

1. Let P be one of a set of forces acting at assigned points of a rigid system, and let A be a point arbitrarily assumed as an origin. At A apply two opposite forces, each equal and parallel to P. Then the original force P is replaced by an equal and parallel force acting at A, and a couple. Each of the forces of the system may be treated in the same way, and the whole set will be replaced by a set of forces acting at A, (which may be combined into a single Resultant R), and a set of couples which may be combined into a single couple G.

2. Since R is compounded of a set of forces which are severally equal and parallel to those of the original set, R evidently remains the same in direction and magnitude, whatever origin be assumed; G in general varies for different origins in both respects, but evidently remains the same for all origins which lie in the direction of R.

3. To examine the changes which G undergoes in passing from one origin to another, let B be any other origin, and at B apply two opposite forces, each equal and parallel to R. We have then, R at B, the couple G, and the newly introduced couple Ra (a being the distance between the directions of R at A and R at B). Now suppose G to be resolved into two couples, whose axes are severally parallel and perpendicular to R; these will be, $G \cos\theta$, and $G \sin\theta$, where θ is the angle between R and the axis of G. Then the axis of the couple Ra being perpendicular to R, this couple will combine with $G \sin\theta$, but will not affect the other resolved part $G \cos\theta$. Hence, whatever origin be adopted, the resolved part $G \cos\theta$, whose axis is in direction of the resultant force, always remains the same. The other component of the couple admits of all values according to the origin adopted. We may therefore adopt an origin (or in fact a line of origins parallel to R) such that this other component shall be zero, and we have then remaining a couple whose axis is in the direction of the resultant force. In this case, the resultant couple evidently has its least possible value.

4. Calling G' this value of it, on transferring to another origin as in (3), the new couple will be compounded of G' and Ra, the axes of which are at right angles to each other; and the new couple

will therefore have the same value so long as a remains the same—that is:—for all origins lying on a circular right cylinder about the line of origins spoken of, and for this reason this line of origins is called by Poinsot the *central axis*.

5. Since R is the same for all origins, the set of forces is not reducible to a single couple, unless it should happen that $R = 0$.

In this case, the forces must be capable of being represented in magnitude and direction by the sides of a polygon (or of several polygons) taken in order. If the forces were represented in position also by the sides of the polygon, and the polygon moreover were a plane one, then the magnitude of the resultant couple would be independent of the position of the forces with regard to the system, being in fact represented geometrically by the area of the polygon.

6. Since $G \cos\theta$ is the same for all origins, the set of forces is not reducible to a single force, unless it should happen that $G \cos \theta = 0$.

That this may be the case, we must either have $G = 0$, or $\theta = \frac{\pi}{2}$; that is:—we must find at our assumed origin either the resultant couple vanishing, or else its axis at right angles to the direction of the resultant force. If the latter be the case at any one origin, it must plainly be so at all origins, and it is easy to see in what way the reduction to a single force is effected. For the plane of the couple can be moved so as to contain R, the couple can be turned till one of its forces is opposite to R, and the arm can be altered till this force is equal to R; these two forces being then removed, there remains the other force (R) of the couple for the single resultant, acting in a line whose distance from the direction of R through our assumed origin is equal to $\frac{G}{R}$. (Of course if R should happen to be 0, this transformation is illusory.) This condition is evidently satisfied when the forces of the system are all parallel, and the single resultant in this case is equal to the algebraic sum of the forces, provided that this sum be finite.

7. Any set of forces can also in the general case be reduced, in an infinite variety of ways, to two, acting along lines which neither meet nor are parallel. For, let the couple G be transferred till the direction of one of its forces intersects that of R; then these two can be compounded into a single force, and this and the remaining force of the couple constitute the two forces acting as stated. The elements of these two forces are of course not

entirely arbitrary, but may be shown to be subject to the condition that $T T' a \sin\phi$ is constant, where T, T', are the two forces, a is the shortest distance between their lines of action, ϕ the angle between these lines. (Cambridge S. H. 1833.) For let the couple be changed so that its forces are T,T, and a is its arm, and let it be placed so that T acts at the same point as R, and the arm is at right angles to R. Then T and R being compounded into T', the angle between T' and T will be ϕ, and we have $T' \sin\phi = R \cos\theta$. Also $G \cos\theta$ being constant, and Ta being equal to G, $Ta \cos\theta$ is constant, and therefore, since R is constant, we have $T T' a \sin\phi$ also constant. This can also be expressed geometrically by saying that if the two forces be represented in position and magnitude by two straight lines, and the extremities of these lines be made the angular points of a pyramid, the volume of this pyramid will remain the same, whatever way of reduction be chosen. This elegant proposition was first given (so far as I am aware) in the *Ladies' Diary*, 1836.

In a subsequent note the analogous propositions in the motion of a rigid system will be discussed.

FORMULÆ FOR THE COSINES AND SINES OF MULTIPLE ARCS.

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§1. Take the expressions,

$$\mathrm{T}_0=2,\ \mathrm{T}_1=1,\ \mathrm{T}_2,\ \mathrm{T}_3,\ \&c.,\ \ldots\ldots\ldots\ldots\ldots \quad (1)$$

So that, t being any quantity, and c a number greater than zero, the relation

$$\mathrm{T}_{c+1}=\mathrm{T}_c-t^2\mathrm{T}_{c-1}\ \ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

always subsists. Hence $\mathrm{T}_2=1-2t^2$, &c. In like manner, take the expressions,

$$t_0=0,\ t_1=1,\ t_2,\ t_3,\ \&c.,\ldots\ldots\ldots\ldots\ldots\ldots \quad (3)$$

So that, t being any quantity, and c a number greater than zero, the the relation

$$t_{c+1}=t_c-t^2t_{c-1}\ \ldots\ldots\ldots\ldots\ldots\ldots \quad (4)$$

always subsists. Hence $t_2=1$, $t_3=1-t^2$, &c. The law of the formation of series (3), expressed in equation (4), being the same with that of series (1), expressed in equation (2), the difference between the series (3) and the series (1) arises solely from the difference in their first terms. The general terms T_m and t_m are easily found. In fact, m being any number greater than zero,

$$T_m=1-mt^2+\frac{mt^4}{\lfloor\underline{2}}(m-3)-\frac{mt^6}{\lfloor\underline{3}}(m-5)(m-4)+\frac{mt^8}{\lfloor\underline{4}}(m-7)(m-6)(m-5)-\&c., \dots\dots\dots \quad (5)$$

$$\text{and } t_m=1-(m-2)t^2+\frac{(m-3)(m-4)}{\lfloor\underline{2}}t^4-\frac{(m-4)(m-5)(m-6)t^6}{\lfloor\underline{3}}+\ \&c., \dots\dots\dots \quad (6)$$

When m is even, the number of terms in the value of T_m is $\frac{m+2}{2}$, and $\frac{m}{2}$ in the value of t_m. When m is odd, the number of terms in each of the expressions T_m and t_m is $\frac{m+1}{2}$. To prove (5), we observe that $T_1=1$, and $T_2=1-2t^2$. Hence the law is true for the first two steps. Assume it to hold for $m-1$ steps. Then

$$T_{m-1}=1-(m-1)t^2+\frac{(m-1)t^4}{\lfloor\underline{2}}(m-3)-\&c.$$

and $t^2\ T_{m-2}= \qquad t^2-(m-2)t^4+\ \&c.$ Therefore, by (2),

$$T_m=1-mt^2+\frac{mt^4}{\lfloor\underline{2}}(m-3)-\ \&c.:$$

which proves the Law universally. In the very same manner equation (6) can be shewn to hold.

§2. The following formulæ may now be established:

$$\text{If } 2t\cos\theta=1, \text{ and } 2t\sin\theta=k,$$
$$\text{then } 2t^m\cos m\theta=T_m, \dots\dots\dots \quad (7)$$
$$\text{and } 2t^m\sin m\theta=kt_m. \dots\dots\dots \quad (8)$$

§3. To prove (7), we remark, that, by hypothesis, the Law holds for the first step, that is, when $m=1$. Assume it to hold for $m-1$ steps. We have only to shew then that it holds for the succeeding step. Now, since the Law holds for $m-1$ steps,

$$T_{m-1}=2t^{m-1}\cos(m-1)\theta=\frac{4t^m\cos(m-1)\theta}{2t}=4t^m\cos\theta\cos(m-1)\theta,$$

and $t^2\,T_{m-2}=2t^m\cos(m—2)\,\theta$. Therefore, by (2),

$$T_m=2t_m\{2\cos\theta\cos(m—1)\,\theta-\cos(m—2)\,\theta\}=2t^m\cos m\,\theta.$$

§4. To prove (8), we observe, that, by hypothesis, the Law holds for the first step, that is, when $m=1$. Assume that it holds for $m—1$ steps. Then

$$kt_{m-1}=2t^{m-1}\sin(m-1\theta=\frac{4t^m\sin(m-1)\theta}{2t}=4t^m\cos\theta\sin(m-1)\theta,$$

and $kt^2t_{m-1}=2t^m\sin(m—2)\,\theta$. Therefore, by (4),

$$kt_m=2t_m\{2\cos\theta\sin(m—1)\,\theta—\sin(m—2)\theta\}=2t^m\sin m\,\theta:$$

which proves the Law universally.

§5. In equations (7) and (8), m may be negative as well as positive. The series (1), starting from the terms T_0 and T_1, may be carried not only forwards in the direction of the terms T_2, T_3, &c., but also backwards through the terms T_{-1}, T_{-2}, &c.; the relation expressed in (2) always subsisting. In fact, by (2),

$$T_1=T_0—t^2T_{-1}\ \therefore T_{-1}=t^{-2}=t^{-2}T_1.$$

In general, it is easily seen that

$$T_{-m}=t^{-2m}\,T_m. \qquad \text{(9)}$$

$$\text{Similarly,}\quad t_{-m}=-t^{2m}t_m. \qquad \text{(10)}$$

By equating the values of T_m in (9) and (7), we have

$$T_{-m}\,t^{2m}=2t^m\cos m\,\theta=2t^m\cos(—m\,\theta)$$

$$\therefore 2t^{-m}\cos(—m\theta)=T_{-m}.$$

In like manner, by equating the values of t_m in (10) and (8), we have

$$2\,t^{-m}\sin(—m\,\theta)=kt_{-m}.$$

§6. As an instance of the application of the formulæ which have been obtained, we shall now find $\cos m\,\theta$ in terms of $\cos\theta$, m being a positive integer. In (5) substitute for T_m its value in (7), and replace t (see §2) by $(2\cos\theta)^{-1}$. Then

$$2t^m\cos m\,\theta=1—mt^2+\frac{mt^4}{\underline{|2}}(m—3)—\frac{mt^6}{\underline{|3}}(m—5)\,(m—4)+\&c.$$

$$\therefore 2\cos m\,\theta=\frac{1}{t^m}—m\,\frac{1}{t^{m-2}}+\&c.$$

$$=(2\cos\theta)^m—m\,(2\cos\theta)^{m-2}+\frac{m(m—3)}{\underline{|2}}(2\cos\theta)^{m-4}—\&c.$$

§7. In like manner, we may find $\sin m\theta$, m being a positive integer. In (6) substitute for t^m its value in (8). Then

$$2k^{-1}t^m \sin m\theta = 1-(m-2)t^2+\frac{(m-3)(m-4)}{\lfloor\underline{2}}t^4-\&c.$$

$$\therefore 2k^{-1}\sin m\theta = t^{-m}-(m-2)t^{-(m-2)}+\frac{(m-3)(m-4)}{\lfloor\underline{2}}t^{-(m-4)}-\&c.$$

But because $2t\cos\theta=1$, and $2t\sin\theta=k$, $k=\dfrac{\sin\theta}{\cos\theta}$. Therefore

$$\frac{2\cos\theta}{\sin\theta}\sin m\theta=(2\cos\theta)^m-(m-2)(2\cos\theta)^{m-2}+\&c.$$

$$\therefore \sin m\theta = \sin\theta\left\{(2\cos\theta)^{m-1}-(m-2)(2\cos\theta)^{m-3}+\&c.\right\}.$$

§8. Another very simple instance of the application of the formulæ which we have obtained is the following. By (2),

$$\begin{aligned}T_{n+1}&=T_n-t^2T_{n-1}=T_n-t^2(T_{n-2}-t^2T_{n-3})=T_n-t^2T_{n-2}+t^4T_{n-3}\\&=\ldots\ldots\\&=T_n-t^2T_{n-2}+t^4T_{n-4}-t^6T_{n-6}+\ldots+(-)^ct^{2c}T_{n-2c}\\&\qquad+(-1)^{c+1}t^{2(c+1)}T_{n-3c-1}.\end{aligned}$$

Substitute for T_{n+1}, T_n, &c., their values in (7), and divide by $2t^n$.

Then

$$\begin{aligned}\cos n\theta-\cos(n-2)\theta+\cos(n-4)\theta-\ldots\ldots+(-1)^c\cos(n-2c)\theta\\=t\left\{\cos(n+1)\theta-(-1)^{c+1}\cos(n-2c-1)\theta\right\}\\=\frac{\cos(n+1)\theta-(-)^{c+1}\cos(n-2c-1)\theta.}{2\cos\theta}\end{aligned}$$

In like manner,

$$\begin{aligned}\sin n\theta-\sin(n-2)\theta+\sin(n-4)\theta-\ldots\ldots+(-1)^c\sin(n-2c)\theta\\=\frac{\sin(n+1)\theta-(-1)^{c+1}\sin(n-2c-1)\theta}{2\cos\theta}\end{aligned}$$

MATHEMATICAL NOTES.

1. *On Linear Asymptotes in Algebraic Curves:*

A method of finding asymptotes, given by D. F. Gregory in Vol. IV., p. 42, of the *Cambridge Mathematical Journal* (to which my attention was called by Prof. Irving), is so elegant and simple that it is surprising it has not yet found its way into the text-books.

Let the equation to the curve, expressed in rational and integral form, be of n dimensions, and be arranged in homogeneous functions of x and y in descending order, as follows:

$$f_n(x, y) + f_{n-1}(x, y) + \dots\dots\dots\dots = 0$$

Then the equations to the asymptotes, (x', y' being current coordinates), are given by

$$\left\{ \begin{array}{l} f_n(x, y) = 0 \\ x' \dfrac{d}{dx} f_n(x, y) + y' \dfrac{d}{dy} f_n(x, y) + f_{n-1}(x, y) = 0 \end{array} \right\}.$$

The expression is left by Gregory in this form, but a little further reduction will give it us in a shape in which the equation to an asymptote can at once be written down by inspection merely. Thus let $\frac{x}{l} - \frac{y}{m}$ be a factor of $f_n(x, y)$, and let $\phi(x, y)$ be the quantity containing the remaining factors, so that the equation to the curve may be written

$$\left(\frac{x}{l} - \frac{y}{m}\right) \phi(x, y) + f_{n-1}(x, y) + \dots\dots\dots = 0$$

then the equation to an asymptote is

$$\left(\frac{x}{l} - \frac{y}{m}\right) \phi(l, m) + f_{n-1}(l, m) = 0.$$

The case of an asymptote parallel to one of the axes (*e.g.*, that of y) is included in this by making $l = 1$, $m = \infty$ and evaluating $(\phi : f_{n-1})$ in the usual way.

The method fails when the above equation becomes indeterminate by the simultaneous vanishing of ϕ and f_{n-1}, which can only happen when $\phi(x, y)$ contains the same factor $\left(\frac{x}{l} - \frac{y}{m}\right)$; that is, when there are parallel asymptotes. Perhaps the easiest way of treating this case is to substitute in the equation to the curve $f(x, y) = 0$, for x and y the quantities $l\,r + x$, $m\,r + y$, and to arrange in descending powers of r. Then, as before, $f_n(l, m) = 0$ will give the directions of the asymptotes, and the coefficient of the next lower power of r which does not identically vanish for these values of $l : m$, will, on being equated to zero, give the asymptotes.

This also shews clearly the reason of the occasional failure of the common rule, when terms of the second highest dimension are wanting, viz.: equate to zero the terms of the highest dimension. The rule succeeds when the expression of the highest dimensions consists of factors occurring singly, but may fail when the same factor occurs in it more than once.

2. *On a Reduction of Curves of the Second Order:*

In the modern system of analytical geometry, as pursued by Salmon, Puckle, and others, the curves of the second order, as represented by the general equation in Cartesian rectangular coordinates, are first separated into central and non-central, and the further reduction of the equation is then effected by transformation of coordinates, which is a rather long and troublesome process. It has occurred to me that this reduction might be simplified by following the course taken by Euclid with regard to the circle, namely, by seeking whether there exists a line (or lines) with regard to which the curve is symmetrical. For this purpose let us take the curves separately.

I. Central curves, $C^2 - AB$ is not zero, and the equation referred to the centre takes the form

$$Ax^2 + By^2 + 2\,Cxy = F.$$

Let the curve be cut by the line

$$\frac{x - \alpha}{l} = \frac{y - \beta}{m} = r,\ (l^2 + m^2 = 1) \ldots\ldots\ldots\ldots (1)$$

then we obtain a quadratic for the values of r at the points of section, by substituting for x, y, in the equation to the curve, and the coefficient of the simple power of r in this, is

$$Al\alpha + Bm\beta + C\,(l\beta + m\alpha),$$

and if this vanish, the values of r are equal and opposite, and (α, β) will be the middle point of the chord of section. Now this condition is

$$(Al + Cm)\,\alpha + (Bm + Cl)\,\beta = 0 \ldots\ldots\ldots\ldots\ldots (2)$$

and if $l : m$ be given, the locus of this equation is a straight line through the origin.

Now we can always assign such a value to $l : m$, that (2) shall be at right angles to (1). For the condition of perpendicularity is

$$\frac{Al + Cm}{l} - \frac{Bm + Cl}{m} = 0,$$

or, $$l^2 - \frac{A - B}{C} lm - m^2 = 0$$

which, being a quadratic in $l : m$ with its last term negative, has necessarily real roots. (Indeed it shews that there are *two* directions, at right angles to each other, in which the chords may be drawn, and in fact gives the directions of the axes of the curve).

Hence there exists a straight line such that it bisects all chords of the curve drawn at right-angles to it; that is, such that the curve is symmetrical with regard to it.

Now let us take this line for the axis of x; then for any given value of x, the equation to the curve must be satisfied by $-y$ as well as $+y$, and this requires $C = 0$. The equation thus reduces to

$$Ax^2 + By^2 = F,$$

the form of it proving again that the axis of y is also a line of symmetry.

The equation is now reducible to the three known varieties, according to the nature of the intercepts of the axes, namely:

(1) .... the ellipse, $\dfrac{x^2}{a^2} + \dfrac{y^2}{b^2} = 1$;

(2) .... the hyperbola $\dfrac{x^2}{a^2} - \dfrac{y^2}{b^2} = \pm 1$, including two intersecting lines $\dfrac{x^2}{a^2} - \dfrac{y^2}{b^2} = 0$,

(3) ......wholly imaginary, $\dfrac{x^2}{a^2} + \dfrac{y^2}{b^2} = -1$.

II. Curves in which the centre is at an infinite distance, and $C^2 = AB$, the equation being

$$Ax^2 + By^2 + 2\,Cxy + 2\,Dx + 2\,Ey = F.$$

The same process as before demonstrates the existence of a line with regard to which the curve is symmetrical. Taking this for axis of x, we must have

$$C = 0, E = 0$$

But $C = 0$ requires either $A = 0$, or, $B = 0$

The latter reduces the equation to

$$Ax^2 + 2\,Dx = F$$

representing two parallel (or, it may be, coincident) straight lines; the former reduces it to

$$By^2 + 2\,Dx = F,$$

and by taking the origin on the curve, still further to

$$y^2 = Lx,$$

representing the parabola.

3. *On a method of Approximating to the Square Root of a Number:*

The following singular proposition is given by Murphy in his *Theory of Equations*, Art. 77, and is very characteristic of a mathematician, perhaps, the most original of modern times. The demonstration that follows is his own, somewhat simplified. Let N be the number, and let $\sqrt{N}$ be between n and $n + 1$. Put $N - n^2 = a$, $(n + 1)^2 - n^2$, or, $(2\,n + 1) = b$. Take any proper fraction $\frac{u_o}{v_o}$, and let a series of fractions be successively formed by the law

$$u_{x+1} = av_x + u_x,\ v_{x+1} = bv_x + u_x,$$

then $\frac{u_x}{v_x}$ converges to the decimal part of $\sqrt{N}$.

For, $\frac{u_{x+1}}{v_{x+1}} = \frac{av_x + u_x}{bv_x + u_x}$, and is a proper fraction since $a < b$,

$$= \frac{a + \frac{u_x}{v_x}}{b + \frac{u_x}{v_x}}$$

Let then $y = \text{Limit}\,\frac{u_x}{v_x} = \text{Limit}\,\frac{u_{x+1}}{v_{x+1}}$;

then ultimately $y = \frac{a + y}{b + y}$

$$\text{or, } y^2 + (b - 1)\,y = a$$

$$\text{and } y^2 + 2ny + n^2 = N.$$

$$\text{whence } y = -n + \sqrt{N},$$

since the positive sign must be taken.

$$\text{Hence, Limit}\,\frac{u_x}{v_x} = \sqrt{N} - n,$$

or $\frac{u_x}{v_x}$ converges to the decimal part of $\sqrt{N}$.

Murphy gives as an example $\sqrt{10}$. Assume the fraction $\frac{1}{6}$; then $a = 1$, $b = 7$, and the successive convergents are

$$\frac{1}{6}, \frac{7}{43}, \frac{25}{154}, \frac{179}{1103}, \frac{1282}{7900}, \cdots\cdots\cdots$$

of which the last written $= 0 \cdot 162278$, which is correct for $\sqrt{10}$ except the final figure which should be 7.

He does not give any method of determining the limits of the error of any convergent, without which the process is of little practical use.

J. B. C.

ABSTRACT OF METEOROLOGICAL OBSERVATIONS, FOR THE YEARS 1861 & 1862, TAKEN AT STRATFORD, CANADA WEST.

BY CHARLES JOHN MACGREGOR, M.A.

HAVING been engaged, in my capacity of head master of the Grammar School, Stratford, in taking the observations required by law to be made at each county town in Upper Canada, I have thought that it would not be uninteresting to the members of the Institute, if I should lay before them the results of these observations for the years 1861 and 1862. I am induced to do so from the fact of having observed, in various numbers of the valuable Journal issued by the Canadian Institute, a notice calling on the members generally to furnish reports of any phenomena that may fall under their observation.

The instruments used were supplied by the Chief Superintendent of Education, and were, I believe, tested at the Provincial Observatory prior to their distribution to the schools. They consist of a barometer, dry and wet bulb hygrometer, maximum and minimum self-registering thermometers, rain gauge, and wind vane. The means are reduced from tri-daily observations taken at 7 a.m., 1 p.m., and 9 p.m. The self-registering thermometers are read at 9 p.m. each day. No observations are taken on Sunday. The thermometers are fixed in position in a shed attached to the Grammar School building, which protects them from being unduly influenced by radiation and the direct force of the wind.

An approximation made by means of the levels taken on the line of the Grand Trunk Railway, kindly furnished me by an engineer of the company, gives the height of Stratford above Lake Ontario at Toronto, as 948 feet, which will consequently make it 1182 feet above the sea level.

GENERAL METEOROLOGICAL REGISTER FOR THE YEARS 1861 AND 1862, TAKEN AT STRATFORD, CANADA WEST.

Elevation above the Sea, 1182 feet.

		January.	February.	March.	April.	May.	June.	July.	August.	Septemb'r.	October.	November.	December.	Winter. Dec. 1860 inclusive.	Spring.	Summer.	Autumn.	Year.
1861	Mean temperature	18°.57	24°.55	26°.77	42°.04	46°.59	62°.33	65°.94	64°.02	56°.47	49°.06	34°.37	31°.66	21°.43	38°.47	64°.10	46°.63	43°.53
	Highest temperature	37.8	50.1	53.6	72.4	70.1	83.9	84.2	90.4	76.1	67.8	50.6	57.5	...	...	...	...	90.4
	Lowest temperature	—20.4	—17.1	— 7.9	23.7	26.2	37.4	36.9	39.9	33.4	24.0	19.0	1.9	...	...	...	...	—20.4
	Monthly & annual ranges	58.2	67.2	61.5	48.7	43.9	46.5	47.3	50.5	42.7	43.8	31.6	55.6	...	...	...	...	110.8
	Mean max. temperature..	24.92	31.08	34.59	49.86	56.15	71.18	74.27	73.89	64.26	57.89	39.34	38.09	...	...	...	...	51.29
	Mean min. temperature...	9.27	15.14	17.44	32.42	36.76	48.56	52.38	53.71	47.06	39.20	28.40	23.56	...	...	...	...	33.66
1862	Mean temperature	19.99	19.87	27.15	40.03	53.18	61.25	65.57	65.73	58.06	47.73	34.22	27.64	23.84	40.12	64.18	46.67	43.37
	Highest temperature	40.1	38.1	40.8	69.2	76.9	79.6	86.0	86.0	79.2	74.6	59.7	52.5	...	...	...	...	86.0
	Lowest temperature	—17.7	—10.4	0.4	15.8	23.9	33.1	40.6	38.9	35.2	23.7	21.8	— 3.1	...	...	...	...	—17.7
	Monthly & annual ranges	57.8	48.5	40.4	53.4	53.0	46.5	45.4	47.1	44.0	50.9	37.9	55.6	...	...	...	...	103.7
	Mean max. temperature...	26.11	26.76	33.29	47.82	63.98	71.16	74.90	74.80	67.91	53.93	39.18	33.38	...	...	...	...	51.10
	Mean min. temperature...	10.95	9.73	18.56	31.66	39.29	46.41	54.46	54.85	47.31	40.05	28.92	20.84	...	...	...	...	33.58
1861	Mean height of barometer	28.6947	28.6033	28.6745	28.6551	28.6717	28.7052	28.6788	28.7850	28.7351	28.6872	28.7235	28.8322	28.6749	28.6671	28.7230	28.6519	28.6955
	Monthly range	1.211	1.015	0.972	0.965	1.118	0.484	0.458	0.420	0.866	1.012	0.886	0.942	...	...	...	...	0.862.
	Greatest daily range	0.649	0.951	0.888	0.498	0.638	0.453	0.226	0.298	0.521	0.595	0.627	0.761	...	...	...	...	...
1862	Mean height of barometer	28.7727	28.6710	28.5807	23.7934	28.7118	28.7003	28.6941	28.7678	28.8075	28.7292	28.7141	28.7532	28.7586	28.6953	28.7207	28.7503	28.7246
	Monthly range	1.150	1.018	0.878	1.045	0.713	0.860	0.680	0.526	0.801	0.896	1.227	1.146	...	..	...	...	0.912
	Greatest daily range	0.913	0.864	0.497	0.695	0.363	0.476	0.403	0.301	0.478	0.581	0.565	0.707	...	...	...	...	...
1861	Mean humidity of the air	87	85	79	70	67	76	82	86	86	85	82	81	...	...	...	...	81
	Mean elas. of aqueous vap.	.096	0.124	0.129	0.209	0.219	0.430	0.536	0.520	0.402	0.319	0.166	0.159	...	...	...	...	0.275
1862	Mean humidity of the air	86	85	81	70	61	71	78	82	82	84	81	86	...	...	...	...	79
	Mean elas. of aqueous vap.	0.102	0.097	0.123	0.190	0.254	0.385	0.497	0.531	0.409	0.302	0.164	0.139	...	...	...	...	0.266
1861	Total amount of rain	0.4138	1.0439	4.4239	2.6122	2.4415	2.3068	4.4772	3.4602	2.9688	4.1070	2.3425	1.2157	...	...	...	...	31.8135
	Number of days of rain...	4	6	10	10	12	11	10	12	15	14	11	4	...	...	...	...	119
1862	Total amount of rain	0.4520	0.1528	2.8133	1.2464	0.9191	3.8408	4.7205	4.1436	4.0103	4.0904	2.9025	2.6885	...	...	...	...	31.9802
	Number of days of rain ...	4	2	6	7	4	8	10	9	11	15	10	5	...	...	...	..	91
1861	Total amount of snow......	25.8	26.7	9.6	5.5	0.6	...	...	...	...	3.0	2.3	6.9	...	...	...	...	80.4
	Number of days of snow...	15	13	13	3	1	...	...	...	...	1	6	7	...	...	...	...	59
1862	Total amount of snow......	24.8	17.0	22.9	Inapp.	...	...	...		...	0.9	4.1	11.1	...	...	...	...	80.8
	Number of days of snow...	16	14	6	2	...	...	...	...	...	3	11	11	...	...	...	...	63

The following table gives the mean temperature and the mean height of the barometer in the different quarters, the winter quarter in each case being taken so as to include December of the preceding year.

	Winter.	Spring.	Summer	Autumn.
1861—Mean temperature..............	21°.43	38°.47	64°.10	46°.63
1862—Mean temperature..............	23.84	40.12	64.18	46.67
1861—Mean height of barometer	28.6749	28.6671	28.7230	28.6819
1862—Mean height of barometer	28.7586	28.6953	28.7207	28.7503

Comparative view, in the years 1861 and 1862, of certain meteorological results :

	1861.	1862.
TEMPERATURE.		
Mean temperature of the year.	43.53	43.37
Warmest month	July	August
When the mean temperature of the month was..	65.94	65.73
Coldest month	January	January
When the mean temperature of the month was..	24.92	26.11
Difference between the warmest and coldest months	41.02	39.62
Warmest day	August 2nd	July 5th
When the mean of the day was	78.5	76.9
Coldest day	Feb. 8th	Jan. 14th
When the mean of the day was	—6.2	1.43
Highest temperature	90.4	86.0
Which occurred on	August 2nd	July 6th Aug. 8th
Lowest temperature	—20.4	—17.7
Which occurred on	Jan. 13th	Dec. 14th
Range of the year............................	110.8	103.7
BAROMETER.		
Mean pressure of the year	28.6955	28.7246
Month of highest pressure	December	September
When the mean pressure of the month was.....	28.8322	28.8075
Month of lowest pressure	February	March
When the mean pressure of the month was.....	28.6033	28.5807
Maximum pressure of the year	29.317	29.436
Which occurred..............................	Jan. 22, 9 p.m.	Nov. 5, 1 p.m.
Minimum pressure of the year	27.943	28.021
Which occurred..............................	May 7, 7 a.m.	March 3, 9 p.m.
Range of the year............................	1.374	1.415

Comparative view of meteorological results—*Continued.*

	1861.	1862.
HUMIDITY.		
Mean humidity of the year	81	79
Month of greatest humidity	October	December
When the mean humidity of the month was	88	86
Month of least humidity	May	May
When the mean humidity of the month was	67	61
RAIN.		
Total depth of rain in inches	31.8135	31.9802
Number of days on which rain fell	119	91
Greatest depth in one month fell in	July	July
When it amounted to	4.4772	4.7205
Rainy days were most frequent in	September	October
When their number was	15	15
SNOW.		
Total depth in the year	80.4	80.8
Number of days on which snow fell	59	63
Greatest depth in one month fell in	February	January
When it amounted to	26.7	24.8
Days of snow were most frequent in	January	January
When their number was	15	16
WIND.		
Most windy month	February	April
Least windy month	August	July
AURORA BOREALIS.		
Aurora visible on	16	16
No. of nights on which it was possible to see aurora	166	162
do. do. impossible to see aurora	199	203
PERIODICAL PHENOMENA.		
Spring birds first seen	March 5	March 17
Crows first seen	——	March 22
Thunder first heard	March 29	April 2
Wild pigeons seen	April 13	——
Mill pond free from ice	April 14	April 15
Swallows seen	——	April 15
Frogs heard	April 20	April 16
Latest snow of the season	May 1	April 23
Currant and lilac bushes in leaf	April 29	May 8
Plum trees in blossom	May 21	May 15
Forest trees in leaf	May 25	May 18
First hoar frost of autumn	——	September 3
First ice of the season	October 21	October 20
First snow of the season	October 23	October 22
Indian summer	——	October 30
Mill pond frozen	November 17	November 9

HALOES.—There were nine lunar haloes observed in 1861, and ten in 1862. Eight solar haloes were observed in 1861, and one in 1862.

Of these, the only one that deserves particular mention was a lunar halo observed on the 16th of June, 1861. It consisted of arcs of three circles. The arc of the circle round the moon had a paraselene near one of its extremities; at the apex of this circle was a tangent circle, apparently of the same radius as the first one; and through the centre of the tangent circle was a third, parallel to the last mentioned, but of a greater radius. The sky at the time was clear, with the exception of light *stratus* clouds, extending from the S.W. to the N. horizon, by which the lower portion of the first mentioned circle was obscured.

NOTICES SCIENTIFIQUES.

PAR. M. ARAGO.

Notice sur les observations qui ont fait connaître la constitution physique du Soleil et celles de diverses étoiles. Esamen des conjectures des anciens philosophes et des données positives des astronomes modernes, sur la place que doit prendre le Soleil parmi le nombre prodigieux d' étoiles dont le firmament est parsemé.

(*Lu dans la séance publique des cinq Académies, le* 25 *Octobre,* 1851.)

[This memoir is an excellent example of the popular and yet strictly scientific *résumes* which we owe to the pen of the illustrious Arago, and is also a good illustration of the charm of his peculiar style. Although recent researches have reversed some of his conclusions, as we have indicated in a few notes, the memoir itself will always be a classic in the history of science, as a thorough reaction of the state of knowledge at the time it was written. Ed.]

Towards the middle of the month of July last, astronomers belonging to the principal observatories in Europe, betook themselves to Norway, Sweden, Germany, and Russia, and fixed their stations in places where the solar eclipse of the 28th of that month would be total. They hoped that this phenomenon, studied with powerful instruments, would lead to plausible explanations of sundry appearances noticed in previous eclipses, on which nobody had dared to pronounce in a decisive manner. "What!" cried some ill-tempered spirits (little acquainted, I must suppose, with the history of astronomy); "What! can the science, which is called the most perfect of all, find still some problems to solve, even with respect to the body around which all the planetary movements are performed? Is it true, that in many respects we are not more advanced than the philosophers of ancient Greece?"

It has been thought that these questions should meet a serious reply, and I have undertaken the task of supplying it, not concealing from myself the dryness which must needs pervade it, nor forgetting that details, which have become at the present day elementary truths, will force themselves prominently under my pen; yet I have thought that your indulgence will not fail to one who is in the performance of a duty.

A general glance at the labors of ancient philosophers and modern observers, will readily prove that, if the sun has been studied for two thousand years, the point of view has often changed, and that, during this interval, science has made immense steps in advance.

Anaxagoras asserted that the sun was scarcely larger than the Peloponnesus. Eudoxus, who enjoyed a great reputation in antiquity, assigned to this star a diameter nine times greater than that of the moon. This was a great step, if we compare this value with that of Anaxagoras, but the number given by the philosopher of Cnidus was still enormously wide of the reality. Cleomedes, who wrote in the reign of Augustus, tells us that the Epicureans, his contemporaries, regarding only appearance, maintained that the real diameter of the sun did not exceed one foot.

Let us now compare with these arbitrary guesses the value which is deduced from the labors of modern astronomers, executed with the most minute care, and by the aid of instruments of extreme delicacy. The sun has a diameter of 357,000 leagues (of 4 kilometres.) There is some difference, we see, between this number and that adopted by the Epicureans.

Supposing the sun to be spherical, his volume is fourteen hundred thousand times that of the earth.

Numbers so enormous not being frequently employed in common life, and failing to convey a precise conception of the magnitudes which they imply, I shall here recall a remark which will enable us better to grasp the immensity of this solar volume. Imagine the centre of the sun to coincide with that of the earth; his surface would then not merely extend to the orbit in which the moon revolves, but would reach nearly as far again beyond.

These results, so remarkable for their immensity, possess all the certainty of the principles of elementary geometry which have served as their base.

The course which I have to pass over being sufficiently long, I will not enter upon any detailed comparison between the results (which are really absurdly small) at which the ancients stopped in estimating the distance of the sun from the earth, and those which have been deduced from modern observations. I shall limit myself to saying here, that it has been *demonstrated*—(and it is not without reason that I make use of so positive a word)—that it has been demonstrated, since the observation of the transit of Venus in 1769, that the mean distance of the sun from the earth is thirty-eight millions of leagues, and that, during summer and winter, his distance from us varies by more than a million leagues. Such is the distance of this immense globe, whose physical constitution modern astronomers have made some progress towards determining. In the ancient philosophers we find nothing on this subject which is worthy of occupying us for a moment. Their disputes on the question as to whether the sun were a fire pure or gross, eternal or capable of extinction, not being founded on observation, left in the deepest darkness the problem which the moderns have tried to solve.

The progress which has been made on this track dates from 1611. At that period, which is not far from the invention of the telescope, a Dutch astronomer (Fabricius) observed distinctly the apparition of some dark spots on the eastern limit of the sun, which, after advancing gradually to the centre, crossed it, and moved to the western edge, disappearing finally after a certain number of days. From these observations, frequently repeated since then, we can infer that the sun is a spherical globe, possessing a motion of rotation about an axis through its centre, the duration of which is twenty-five days and a half.

These dark spots, variable and irregular, but well defined in outline, have sometimes considerable dimensions; some of them have been observed of a magnitude more than five times that of the earth. They are generally surrounded by an *aureola* less luminous than the rest of the surface of the star, to which has been given the name of *penumbra*. This penumbra, first remarked by Galileo, and carefully observed, with reference to the changes it undergoes, by astronomers since his day, has led to a supposition with respect to the physical constitution of the sun, which at first sight looks singular enough.

The sun might be a dark body, surrounded by an atmosphere at some distance, which is comparable with the atmosphere of the earth, as being the seat of a continuous layer of opake and reflective clouds. To this first atmosphere might succeed a second, self-luminous, which has been called the *photosphere,* and this, distant more or less from the interior cloudy atmosphere, would determine by its outline the visible limits of the star. Pursuing this hypothesis, spots would be formed on the sun, as often as there occurred, in these two concentric atmospheres, corresponding openings *(eclaircies)* which permitted a view of the dark central body. Persons who have studied the phenomena with powerful telescopes—astronomers by profession, and competent judges—recognize in the hypothesis of the sun's physical constitution, which I am going to speak of, a satisfactory account of the observed facts, yet it is not generally adopted.* Some writers of authority would represent the spots to be merely *scoriæ* floating on the liquid surface of the star, and given out by the solar volcanoes, of which we have only a feeble image in those of our earth. It was desirable, therefore, that we should proceed, by direct observations, to determine the nature of the sun's incandescent matter. But when we reflect that we are distant from this star by an interval of thirty-eight millions of leagues, and that we can only communicate with his visible surface by means of the luminous rays which proceed from it, to propose this problem to ourselves seemed to be unjustifiable rashness. The recent progress in the science of Optics has, however, furnished the means of completely solving it, and certain details, which you will pardon my laying before you, will render this solution evident. Everybody at the present day is aware that physicists have been led to distinguish two kinds of light—natural and polarized. A ray of the first species possesses properties which are the same for each point of its contour ; but it is not so for polarized light, where different sides of the rays have not the same properties. These differences are shewn in numerous phenomena which I need not here mention. Before going further, let us remark that there is something strange in the results which have logically led physicists to speak of different sides of a ray of light, thus drawing a distinction between one side and another; and the word *strange*, which I have used advisedly, will certainly appear natural to those who reflect that millions upon millions of these rays can pass together through the eye of a needle without interfering with each other.

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* At the present day this hypothesis finds even still less favor. We shall see presently that the argument for the existence of this dark central body is inconclusive, and is opposed to more recent experiments. All the phenomena connected with the spots can be satisfactorily explained on the supposition that they are cloudy masses floating in the sun's atmosphere; of the reality of which clouds the subsequent remarks of the author leave no doubt. —(*Trans.*)

The polarization of light has enabled astronomers to enrich their means of investigation, by the addition of some curious instruments which have already done good service, and among these is the one named the *polariscope*.

If you look directly at the sun through one of these polariscopes, you will see two images of the same intensity and tint—both white. Suppose, now, that you look at the sun's image reflected at the surface of water, or of a glass mirror. In the act of reflexion, the rays become polarized; the polariscope no longer gives two white and similar images, but on the contrary, they are tinted with most vivid colors, although their form does not undergo alteration. If the one is red, the other will be green; if the first is yellow, the second will have the violet tint, and so on—the two tints being always *complementary*, as it is called, that is, capable of forming white light by their mixture. Whatever be the process by which natural light becomes polarized, the colors are exhibited in the two images of the polariscope, just as if we had been looking at light reflected from water or glass. The polariscope, then, furnishes a very simple mode of distinguishing polarized from natural light.

It was for a long time thought that the light proceeding from any incandescent body reaches the eye in the condition of natural light, provided that in the passage it had not been partially reflected, or much refracted, but this proposition fails in certain cases. A member of the Academy has discovered that the light which proceeds, under a sufficiently small angle, from the surface of an incandescent body, whether liquid or solid, and even when it is not polished, offers evident traces of polarization, so that by passing into the polariscope it becomes decomposed into two colored portions (*faisceaux colorès*). The light which proceeds from a gaseous substance in the act of burning (as the gas which to-day illuminates our streets and shops) is, on the contrary, always in its natural state, whatever may have been the angle of emission.*

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* The incandescent bodies of which the light emitted under different angles has been examined with the polariscope, are the following: *solids*, forged iron and platinum; *liquids*, melted iron and fused glass. According to these experiments, some one may say, you have a right to affirm that the sun is neither melted iron nor fused glass, but what authorises you to

The process in order to decide whether the substance which renders the sun visible is liquid, solid, or gaseous, will be nothing more than a very simple application of the preceding remarks, notwithstanding the difficulties which appeared to arise from the enormous distance of that star.

The rays which render visible to us the borders of the disk have evidently issued from the incandescent surface at a very small angle. If, then, the borders of the two images seen directly through the polariscope, appear colored, the light of these borders must proceed from a liquid body, for every supposition which would make the exterior of the sun a *solid* body is definitely excluded by the observation of the rapid change of form in the spots. And if the borders retain in the polariscope their natural whiteness, they are of necessity gaseous in character. Now, observations made by viewing the sun directly any day of the year through large polariscopes, fail to discover the least trace of polarization. Therefore the substance in combustion which defines the sun's outline is gaseous, and we can generalize this conclusion, because the different points of the sun's disk, by reason of the movement of rotation, come, each in its turn, on the border.

This experiment removes from the region of mere hypothesis the theory we have above indicated of the physical constitution of the solar photosphere.

We do not find any thing, properly understood, either in the arbi-

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generalise? This is my answer; according to the two only explanations that have been given of the abnormal polarization presented by the rays emitted under small angles, the results ought to be the same in all respects, except that of magnitude, whatever be the liquid examined, provided that the surface of emergence has a sensible reflecting power. The only case of exception might be that of an incandescent body which should be, as regards density, analogous to a gas, as, for example, the fluid of an almost ideal rarity, which many geometers have been led to place hypothetically at the extreme limit of our atmosphere, where the phenomena of polarization and color might possibly disappear. I am not ignorant that I should add weight to the results mentioned in the text, by discussing them in a photometric point of view. I possess all the materials for such an examination, but this is not the place to develope them. I will, however, here anticipate a difficulty. It ought to be remarked that the lights proceeding from two liquid substances may, according to the special nature of these substances, not be identical as regards the number and position of the dark lines of Fraunhofer, which occur in their prismatic spectra. These differences are of a kind to be considerably augmented by the differently constituted atmospheres which the rays have traversed before reaching the observer.—(*Author's note.*)

The experiments spoken of in the text and note have been objected to as inconclusive, by M. Kirchoff, on the ground that the liquids there examined were in a state of rest. If their surfaces were in much agitation, as that of the sun must doubtless be, the rays would be emitted at all angles, and every trace of polarization would probably disappear. In addition to this, it may be remarked that Arago takes no account of the possible effect which might be produced on the rays by passing through the sun's atmosphere.—(*Trans.*)

trary conceptions springing from the brilliant imagination of the ancient Greek philosophers, or in the relics of the labors of the most famous astronomers of the Alexandrian school, which can, even by a forced comparison, be likened to the results I am announcing. These results, let us loudly proclaim, are due entirely to the united efforts of observers of the 17th and 18th centuries, as well as, in part, to those of our contemporary astronomers.

Let us here notice a remark which we shall presently have occasion to apply when we endeavour to determine the physical constitution of the stars.

If the matter of the solar photosphere be liquid, and so the rays issuing from its border be polarized, we shall not merely see colors in each of the two images given by the polariscope, but they will be different at different points of the contour. If the highest point in one of the images is red, the point diametrically opposite in this image will also be red. But the two extremities of the horizontal diameter will both be green, and so on. If, then, we proceed to reunite, in a single point, the rays proceeding from all parts of the sun's limb, even after their decomposition in the polariscope, the mixture will be white. Such a constitution of the sun as I am here establishing will equally serve to explain the existence on its surface of spots not dark but luminous. The former, which are designated *faculæ* (*facules*), were first observed by Galileo ; the others, of much smaller extent, and for the most part circular in form, were seen by Scheiner* and by him denominated *maculæ* (*lucules*), and give to the sun's surface a sparkling appearance. I may refer (a somewhat singular circumstance) the discovery of one of the principal causes of these faculæ and maculæ to an administrative visit I paid to a fashionable shop on our Boulevards.

"I have reason to complain of the gas company," said the proprietor of the establishment; "they ought to turn on to my goods the broadest part of this bat-wing jet, and yet often, through the negligence of their agents, they place it so as to throw the light edgeways." "Are you quite sure," replied one of the assistants, "that in this position the flame throws less illumination than in the other?" The doubt appearing ill-founded, and, I may say, even absurd, exact experiments were resorted to, and it turned out that a flame throws the same quantity of light on an object whether the broad part or the edge of the flame is turned to it.* It follows from this that an incandescent surface of gas of a definite extent appears more luminous when we view it obliquely than under a perpendicular incidence; and consequently if the sun's surface presents inequalities, like our atmosphere when it is covered with dappled clouds, it ought to appear feebly illuminated in comparison in those portions of the inequalities which are presented to the observer perpendicularly, and more brilliantly in the portions oblique to him. Every conical cavity ought then to appear to us as a *lucule.* It is not therefore necessary for the explanation of the appearances to suppose the existence of millions of points more incandescent than the rest of the disk, or of millions of spots distinguished from the neighbouring regions by a greater accumulation of luminous matter.†

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* Scheiner's claim to the discovery is doubtful. John Fabricius and Galileo were the first observers of them, nearly contemporaneously, and Harriott also, a little later. made the same observations independently.—(*Trans.*)

After having proved that the sun consists of a dark central body, of a cloudy reflective atmosphere, and of a photosphere,‡ we ought naturally to ask if there is nothing beyond, and whether the photosphere ends abruptly without being surrounded by a gaseous atmosphere, less luminous than itself and of feeble reflective power. This third atmosphere would commonly disappear in the ocean of light by which the sun appears always surrounded, and which arises from the reflection of his rays by the particles composing the terrestrial atmosphere.

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* If $2b$ be the length of the jet, considered as a luminous line, and h the distance of an illuminated small area from the centre, the ratio of the intensities of the illumination in the two cases will be as $\sqrt{\left\{1+\frac{b^2}{h^2}\right\}}$ to $1-\frac{b^2}{h^2}$ which if b be small compared with h is sensibly 1. (*Trans.*)

† We may add here the curious discovery of Mr. Nasmith, that the surface of the sun is mottled with an enormous number of lens-shaped or willow-leaved figures, disposed without the least attempt at symmetry. Also the fact of the decennial period of a maximum occurrence of the solar spots, and its coincidence with a corresponding maximum in the disturbance of the terrestrial magnetism due to the sun.—(*Trans.*)

‡ The recent researches of MM. Kirchoff and Bunsen, on the prismatic spectrum, which have led to the most beautiful discovery of modern times, have thrown an unexpected light on the question here discussed by Arago. The following brief resumè may be excused. The light proceeding from incandescent bodies, whether solid or liquid, gives a continuous spectrum when refracted through a prism, but when a flame in which such substances are volatilised is examined, the spectrum is found to be crossed by a number of bright lines of different colors, the number and position of such lines for each distinct substance being always the same. When a pure light is transmitted through such a flame, so as to overpower it, the bright lines become replaced by dark ones in the same positions. Now, when the solar beam is examined, it is found to be crossed by dark lines, which occupy the known places of the bright lines of various substances. It is thence inferred that the light of the sun proceeds from an incandescent solid or liquid body, and has passed through a vapor in which these substances are volatilised. Among the substances thus detected are sodium, lithium, iron, calcium, magnesium, chrome, nickel, cobalt, barium, copper, zinc, besides very many yet undetermined. Hence we are led to reject the hypothesis of Arago, (or rather of W. Herschel) and to adopt the more obvious supposition, that we really see the incandescent body of the sun through a transparent atmosphere, of considerable extent and feeble illumination, in which many known terrestrial substances exist in a state of vapor.—(*Trans.*)

A mode of resolving this doubt presented itself, by choosing the moment in a solar eclipse when the moon completely covers the sun. Just at the instant when the last rays issuing from the borders of the luminary disappear behind the opaque screen formed by the moon, our atmosphere, in the region where the two bodies are projected, and the surrounding parts, cease to be illuminated.

Now we see what was the principal object aimed at by the astronomers who in 1842 betook themselves to the south of France, to Italy, Germany and Russia, where the solar eclipse of July 8 would be total.

In researches of every kind, the part played by the unforeseen is always immense. Thus the observers were strangely surprised, when, after the disappearance of the last direct rays of the sun behind the rim of the moon, and of the light reflected by the surrounding terrestial atmosphere, they saw some rose-colored protuberances, of from two to three minutes in height, shoot forth. so to speak, from the contour of our satellite. Each astronomer, following the ordinary bent of his ideas, arrived at a particular conclusion as to the cause of these appearances. Some attributed them to mountains of the moon, but this hypothesis will not bear a moment's examination; others would see in them only the effects of diffraction or refraction. But calculation is the touch-stone of all theories, and the most indefinite vagueness was found to accompany those of which I am speaking in their application to the phenomena under notice. Explanations which give us no precise account either of the height, the form, the color, or the permanence of a phenomenon, ought not to find place in Science.

Let us take up the idea, strongly recommended for a time, that the protuberances of 1842 were solar mountains whose summits passed beyond the photosphere covered by the moon at the moment of observation.

According to the most moderate computation, the height of one of these summits above the sun's disk must have been 19000 leagues. I am well aware that no argument based on the enormous amount of this height ought to lead to a rejection of the hypothesis. But we can forcibly upset it by remarking that these pretended mountains had large portions out of the perpendicular, which consequently in virtue of the sun's attraction ought to have overturned.

Let us cast a rapid glance at a fourth hypothesis, according to which these protuberances resembled solar clouds swimming in a gaseous atmosphere. We shall not find any physical principle which will prevent our admitting the existence of cloudy masses of from 25 to 30,000 leagues in length, with abrupt and irregular contorted outlines. Only, in following the hypothesis further, we shall claim the right to be astonished that no such solar cloud had ever been seen entirely separated from the limb of the moon, and it was to this point, the crucial test, that the researches of astronomers had to be directed. A mountain not being able to sustain itself without a base, there was only wanting a chance observation of a protuberance visibly separated from the moon's limb (and, by consequence, from the real border of the solar photosphere) to overthrow the hypothesis of solar mountains from top to bottom. But, let us here mark well, it is not in astronomical researches as in those of chemists and physicists. These latter have the power of varying at will the conditions under which they work, and of changing the nature of their results; but astronomers can exercise no influence on the phenomena they are studying, and are obliged to wait sometimes for centuries in order that the stars may present themselves in positions favorable for the solution of a difficulty.

In the present case, the doubtful points raised by the observations of 1842 have already been able to be submitted to a new experimental examination, during the last year. An eclipse of the sun was announced for August 8, 1850, which would be total in the Sandwich Islands. The naval captain, Bonnard, in command of our station at Otaheite, was struck by the happy idea of dispatching the engineer of bridges and roads, M. Kutscyki, from the island of Tahiti to Honolulu, the capital of the Sandwich archipelago. The account which we have received from this able observer contains the following passage :—" The part, detached and reddish in color, which was near the northern protuberance, has appeared completely separated from the limb of the moon." Later, in the eclipse of July 28, 1851, MM. Mauvais and Goujon, at Dantzic, and the foreign astronomers of great celebrity who had gone to divers points of Norway, Sweden, and North Germany, saw, all of them, at every station, a spot, likewise of reddish hue, which was separated from the moon's limb.

The observation of M. Kutscyki, and the concordant observations of 1851, put a stop without possibility of recurrence to those explanations of the protuberances which are founded on the supposition that there existed in the sun mountains whose summits extended considerably beyond the photosphere.

When it shall be rigorously proved that these luminous phenomena cannot be the effect of the inflexions which the sun's rays undergo in passing near the inequalities which border the moon's contour; when it shall be proved that these rosy tints cannot be assimilated with mere optical appearances—that they have a real existence, and are veritable solar clouds :—then we shall have a new atmosphere to add to the two of which we have already spoken, for clouds could not sustain themselves in a vacuum.*

Everyone now knows what the uncertainty is which remains as to a very special point in the sun's physical constitution. When we reflect that the phenomena which might serve to resolve all our doubts are habitually invisible and that they can only be seen during total eclipses of the sun—that such total eclipses are few in number—that, since the invention of the telescope, the astronomers of Europe and America have hardly had the opportunity of making proper observations on more than six occasions—no one will have a right to be astonished that, in the middle of the 19th century, the question raised by these mysterious red flames, of which we have spoken so much, is yet a subject of study.

After these examinations, of which you will pardon the length, let us indicate in few words the series of measurements and deductions by which Science has been able to fix the sun's real place in the totality of the universe.

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* In order that these clouds might sustain themselves in a vacuum, it would be necessary that the centrifugal force arising from their circular motion should be at each instant equal to the gravitation which would tend to make them fall to the sun. It would be necessary to transform them into actual planets revolving about this body with an extreme rapidity. Such is, in substance, the explanation which M. Babinet has given of the protuberances of 1842, at the meeting of the Academy of Sciences, on 16 February, 1846. The reader will see, in the memoir of the learned academician, the ingenious considerations on which this theory reposes, and how it may be connected with the cosmogonic system of Laplace. I believe, now that the phenomenon has been minutely observed, that M. Babinet will find more than one difficulty in reconciling the immense velocity which he is forced to assign to the matter of those protuberances, with the relative immobility of those which were observed in 1851, and the change of height which they presented. These difficulties disappear when the spots are assimilated to clouds, floating in a solar atmosphere which has a rotatory motion of small rapidity. I would besides remark that the existence of this third atmosphere is established by phenomena of an altogether different kind, namely, by the comparative intensities of the rim and centre of the sun, and also, in some respects, by the zodiacal light which is so visible in our climates at the time of the equinoxes. But the question considered in this point of view would require details that I am forced to omit.—(*Author's note.*)

The existence of an atmosphere extending beyond the visible photosphere is certainly proved by its actual appearance in the shape of a corona or ring of light, which is seen to surround the sun during a total eclipse.—(*Trans.*)

Archelaus, who lived 448 B.C., and was the last philosopher of the Ionian sect, said of the sun—"He is a star; only this star exceeds all the rest in magnitude." This conjecture (for that which is founded neither on measurement nor experiment deserves no other name) was certainly very bold and beautiful. Let us pass across an interval of more than two thousand years, and we shall find the relations between the sun and the stars established by the labors of the moderns on bases which defy all criticism. About a century and a half ago, astronomers sought to determine the distance of the stars from the earth. Repeated unsuccessful attempts seemed to prove that the problem was insoluble. But what are the obstacles over which genius united to perseverance cannot ultimately prevail? We have learned within the last few years the distance which separates us from the nearest stars. This distance is about 206,000 times the sun's distance from the earth, that is more than 206,000 times 38 millions of leagues. The product of 206,000 times 38,000,000 would too far exceed numbers we are in the habit of considering, to render it of any use to state. The imagination will be more struck by the immensity of this number if I connect it with the velocity of light. The star Alpha of the constellation Centaur is the earth's nearest neighbour, if indeed we may speak at all of neighbourhood when we are dealing with such distances as in this case. The light of Alpha Centauri takes more than three years to reach us, so that if the star were annihilated, we should still see it for three years after its extinction. When we remember that light traverses 77,000 leagues (308,000 kilometres) in a second of time, that the day is composed of 86,400 seconds, and the year of 365 days, we may well stand, as it were, aghast at the immensity of these numbers. Furnished with these data, let us transport the sun to the distance of the star which is nearest to us of all, then this circular disk so vast, which in the morning lifts itself so gradually and majestically above the horizon, and in the evening takes a considerable time to descend completely below that plane, will no longer possess sensible dimension even in the strongest telescopes, and its brightness will range it among stars of the third magnitude. You see, gentlemen, what has become of the conjecture of Archelaus! We may possibly feel a little humiliated at the result which reduces to so small a matter our place in the material world. But let us reflect that man has arrived at this result by drawing all from his own peculiar fund, and we shall recognise in this his elevation to the most eminent rank in the domain of ideas. Astronomical investigations may therefore well excuse a little vanity on our part.

Would that it were permitted to me to follow modern astronomers in their immortal career across the multitude of suns that glitter in the firmament!

We should observe them, in the first place, determining with the aid of their instruments the relative positions of these stars by cataloguing some hundred thousand of them. We know that the Elder Pliny was astonished that Hipparchus had endeavoured to observe 1022 of them, and that he compared this work to that of a deity! We should remark in some recent works complete enumerations which would show us that the number of stars visible to the naked eye in a single hemisphere—the Northern—is less than 3000—a result which is certain, but which, from its smallness, will strike with astonishment those who have vaguely examined the heavens in the fine winter nights. This astonishment would change its nature if we pass to the telescopic stars. In this case, carrying the enumeration as far as stars of the fourteenth magnitude, the last we can perceive in our most powerful telescopes, we should find, by a calculation which furnishes only an inferior limit, a number greater than forty millions (forty millions of suns!!), and the distance of the furthest of them would be such that light would require from three to four thousand years to traverse it. We should then be amply authorised to say that the rays of light, these messengers so rapid, bring to us, if we may so speak, the very ancient history of these distant worlds.

A photometric investigation, of which the first hint is to be found in the Cosmotheoros of Huyghens, undertaken by Wollaston a short time before his death, would teach us that it would be necessary to unite twenty thousand stars like Sirius, the most brilliant of the firmament, in order to throw upon our globe a light equal to that of the sun.

Guided by the genius of William Herschel, we should examine the stars which are apparently in contact, and this great astronomer would prove to us that these stars, coupled together in some manner, do not merely appear to us near to each other by an effect of perspective, but are really in mutual dependence, and revolve about their common centre of gravity in periods of sufficiently short duration, which have already in certain cases admitted of determination. Observing that these double stars are of colors very unlike, our thoughts would naturally be carried to the inhabitants of the planetary bodies, non-luminous and turning about their own axes, which to all appearance revolve about these suns, and we should remark, not without a real anxiety for the works of the painters in these distant worlds, that to a day illuminated by a red light there succeeds, not indeed a night, but another day, of equal brilliancy, only illuminated by a green light. The comparisons of the positions of the stars determined at different epochs would prove to us that they are very improperly denominated *fixed;* that in fact they are in motion in space in different directions, so that in the course of time, the form of the actual constellations will be completely changed; that the absolute velocities of these stars are unequal, but that the velocity in one of the cases which have been determined with entire certainty is at the rate of twenty leagues a second; lastly that the sun, like all the other stars in this respect, is not stationary, and carries in his train the family of planets with which he is surrounded. We should be struck by the unequal distribution of the stars in the celestial sphere. In one place, we should see more than twenty thousand in an area equal to the tenth part of the moon's apparent surface. In another, in an area of the same extent, not a single luminous point would be visible, even with the best telescopes.

After having cast an attentive glance at the luminous matter scattered over immense spaces, which, by its agglomeration continued through centuries, seems capable of giving birth to new stars, we should discuss the noble conceptions of Wright, Kant, Lambert, and W. Herschel, on the constitution and dimensions of the milky way. Finally, some steps further in conjectural astronomy—that is to say, in that branch of the science which rests only on imposing probabilities and natural generalisations, there would be unveiled to us phenomena, which by their nature, or the enormity of the numbers which measure them, would cast the strongest minds into a sort of vertigo.

But let us leave these speculations, however worthy of admiration they be, to return to the main question which I proposed to treat in this note, and to try, if it is possible, to establish some connexion between the physical nature of the stars and that of our sun.

We have succeeded, by aid of the polariscope, in determining the nature of the substance which composes the solar photosphere, because, by reason of the large apparent diameter of this body, it has been possible to observe separately different points of his contour. If the sun were removed from us to the distance where his apparent diameter would be inappreciable, as that of the stars is, the method would become inapplicable. The colored rays, proceeding from different points of his contour, would then be found closely mingled, and we have already said that their mixture would produce white. It appears then that we must give up the application to stars not possessing sensible dimensions of the process which has led us so well to our goal in the case of the sun. There are however certain of these stars which lend themselves to this method of investigation. I allude to variable stars.

Astronomers have remarked stars whose brightness changes considerably. There are some of them which pass in a very small number of hours from the second to the fourth magnitude. There are others in which the change of brilliancy is much more decided. Such stars, very visible at certain epochs, disappear afterwards totally, to appear anew after intervals, longer or shorter, and subject to some slight irregularities. Two explanations of these curious phenomena present themselves to the mind. One of which consists in supposing that the star is not equally luminous at all points of its surface, and that it has a motion of rotation on its own axis. Consequently, it appears brilliant when its luminous face is turned towards the earth, and sombre when its dark face comes into that position. On the second hypothesis, a satellite, opaque and not self-luminous, revolving about the star, would periodically eclipse it.

In reasoning on one or other of these two suppositions, the light which is sent to us some time before the disappearance or the reappearance of the star, has not issued from all the points of its contour, and there can no longer be occasion for the complete neutralisation of the tints we just now spoke of. If a variable star, examined with the polariscope, remains perfectly white in all its phases, we may be sure that its light proceeds from a substance like our clouds or burning gases. Now, such is the result of the small number of observations that we have yet been able to make, and which it will be of much utility to complete.* This same mode of investigation requires more care, but succeeds equally well when it is applied to stars which undergo only a partial variation of brightness. The result to which these observations lead us, and which we can, I believe, generalise without scruple, can be announced as follows :—our sun is a star, and its physical constitution is identical with that of the millions of suns with which our firmament is everywhere strewn. I have been compelled, in the duty which was committed to me in the commencement, to give a sketch of all our present knowledge relative to the volume, distance, and physical constitution of the immense globe which illuminates us. This sketch, within the prescribed limits, will be sufficient to undeceive those persons who had thought it necessary to call in question the importance and certainty of the results obtained by modern astronomers. They will acknowledge, if they are candid, that in the history of the progress of knowledge, a progress which will without doubt be unlimited, the labors of the astronomers of the nineteenth century will not pass unperceived. As to criticisms not inspired by the love of truth, they would not deserve to fix for a moment the attention of this assembly, and I think that I may, for my own part, pass them by with contempt.—*Translated from the "Annuaire du Bureau des Longitudes pour l'an* 1852."

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* I am not aware that these experiments have been successfully prosecuted, but the method of prismatic examination of Kirchoff and Bunsen, alluded to in a previous note, has been applied with success to various stars, and has resulted in similar conclusions to those drawn in the case of the sun.—(*Trans.*)

J. B. C.

SCIENTIFIC AND LITERARY NOTES.

THE ENTOMOLOGICAL SOCIETY OF CANADA.

A meeting of Canadian Entomologists was held at Toronto, in the rooms of the Canadian Institute, on Thursday, the 16th of April, for the purpose of taking into consideration the propriety of forming a society for the advancement of Entomological pursuits.

The following gentlemen were present:—Rev. Prof. W. Hincks, F.L.S.; Prof. H. Croft, D.C.L.; Beverly R. Morris, Esq., M.D.; J. H. Sangster, Esq., A.M.; and J. Hubbart, Esq., of Toronto. Thomas Cowdry, Esq., M.D.; and H. Cowdry, Esq., York Mills. Rev. C. J. S. Bethune, M.A. Cobourg; and W. Saunders, Esq., London.

Prof. Hincks was appointed chairman, and Mr. Bethune Secretary *pro tem.*

Letters of apology for non attendance were read from E. Billings, Esq. F.G.S., Montreal; R. V. Rogers, Esq., Kingston; F. Reynolds, Esq., Hamilton; B. Billings, Esq., Prescott; Rev. V. Clementi, B.A., Peterboro'; and E. B. Reed, Esq., London. These gentlemen expressed deep regret at their inability to attend, and pledged themselves to do all in their power to further the interests of the society.

The following resolutions were then unanimously adopted.

1st. That a society be formed to be called the Entomological Society of Canada; consisting of all students and lovers of Entomology, who shall express their desire to join it, and conform to its regulations.

2nd. That its officers shall consist of a President, a Secretary, Treasurer, and a Curator; to be elected annually, at the first general meeting in each year; whose duty it shall be to manage the affairs of the society.

3rd. That the annual contribution of members shall be two dollars, to be paid in advance.

4th. That application be made to the Canadian Institute for the use of a room in their building for the purposes of the society.

5th. That two separate collections be formed, a general one to be the property of the Canadian Institute, and a duplicate one to be the property of the society, and to consist of all surplus specimens contributed to the Society by members; and that all members be at liberty to exchange species for species under the supervision of the Curator.

6th. That meetings be held at 3 p. m., on the first Tuesday in each month, and that special meetings may be called when necessary by the officers.

7th. That Prof. Croft be President for the present year; that Mr. W. Saunders be the Secretary-Treasurer, and Mr. J. Hubbart the Curator.

8th. That the President be authorized to bring the subject before the council of the Canadian Institute at its next meeting.

The following papers were then read to the society :—Insect life in Canada; March and April," by the Rev. C. J. S. Bethune; and a synopsis of Canadian arctiidae" by W. Saunders; the latter illustrated by a complete series of specimens.

A number of interesting insects were brought to the meeting for inspection, chiefly from the collections of Dr. Morris and W. Saunders. Among others, Canadian specimens of the following were much admired. Limenitis ursula, Vanessa cænia, Mellitæa nycteis, M. phaeton, Thecla niphon, T. mopsus, T. laeta, Lycæna neglecta, Polyommatus dorcas, Hesperia mystic, H. wamsutta, and Pamphila numitor. A specimen of Colias eurytheme, though not itself Canadian, was regarded with great interest, from the fact that a specimen had been captured last fall, near St. Catharines, by D. W. Beadle, Esq.

The pretty little moths, Glaucopis semidiaphana and Melanippe propriaria, were duly represented, also beautiful specimens of Arctia dione, and sphinx drupiferarum.

Magnificent specimens of Ceratocampa regalis, and Dryocampa imperialis, were exhibited, and, although not natives, the probability of their being yet found with us, gave them an additional interest.

Among the Coleoptera we observed some rarities; for example, Xyloryctes satyrus, Canthon chalcites, Chlænius lithophilus, Colosoma frigidnm, Geotrupes splendidus, Bolbocerus Lazarus, Aphonus frater, and Leptura nitens; all natives of Canada.

After a careful examination of all that was interesting, the meeting adjourned each one highly pleased with the results of the gathering.

The application for the use of a room, in the building of the Canadian Institute, for the purposes of the Society, was brought before the Council, by the President at their meeting, on Saturday, the 18th, when they very liberally granted it, free of expense.

The Society thus formed, will, we trust, be a prosperous one. The number of Entomologists in this country is not large, but they are amply sufficient to sustain an organization of this sort. The advantages the Society offers to its members are not by any means small. The general collection will be open to all for purposes of reference and comparison, and will thus afford valuable opportunities to those who wish to name their specimens; while the cabinet of duplicates will offer means of exchange with all parts of Canada. It is intended that duplicate copies of Entomological papers published by those connected with the Society shall be left with the curator for distribution among members. It is probable, also, that as soon as the funds will permit an Entomological library will be added to the other attractions in the Society's rooms; and that a stock of pins will be purchased from which members may obtain supplies at cost price.

That the meetings of the Society may be made as interesting and attractive as possible, it is desirable that members from a distance would furnish short monthly records of interesting captures in their localities, accompanied, where convenient, with specimens of the insects spoken of.

All lovers of Entomology may become members of the Society by remitting the amount of the yearly subscription to the Secretary-Treasurer,

William Saunders, London, C. W.

THE GORILLA.

During the last meeting of the British Association at Cambridge a smart attack was made upon Professor Owen's views respecting the importance of the characters of the brain in man as distinguishing him from the monkeys as well as from inferior animals, by Professor Huxley, supported by Professor Rolleston and Mr. Flowers. It is known to all students in zoology, who attempt to keep up with the times, that Professor Owen some time since proposed an improved arrangement of Mammalia, in which the leading divisions are made to depend on the degree of development of the brain. In this system there are four primary divisions; one of which is occupied by man alone, whilst in the second the Quadrumana (the ape and monkey tribe), with the Carnivora and other important tribes of Mammals, form an extensive group. The tabular view of Professor Owen's plan was given in this *Journal* at the time of its publication, and may be referred to by our readers. Professor Huxley immediately called in question the importance, and, to a certain extent, the reality of the distinctions drawn by Owen, and a controversy has been carried on for several years. On the present occasion Professor Owen brings before the Natural History section of the association a paper entitled, "On the Zoological significance of the Brain and Limb-characters of Man, with remarks on the cast of the Brain of the Gorilla." The main object of this paper is to justify the system previously proposed by a further exposition of the differences between the Human brain and that of the Quadrumana, as seen in its highest form in the Gorilla. In a paper published as an appendix to his lecture on Sir Robert Reade's foundation, delivered before the University of Cambridge in 1859, Owen had fully given his reasons for continuing to place the Ourangs above the long armed apes, and for regarding the Gorilla as the highest known development of Quadrumana. He now, therefore, by means of a cast from the interior of the Gorilla's skull, brings the brain of this animal, which may be taken as the nearest approach to man, into direct comparison with the Human, and he considers the result as confirming his previous conclusions. "In the brain of man the posterior lobes of the cerebrum overlap, to a considerable extent, the cerebellum; whereas in the Gorilla the posterior lobes of the cerebrum do not project beyond the lobes of the cerebellum. The posterior lobes in the one are prominent and well-marked, in the other deficient. He had placed man—owing to the prominence of the posterior lobes of his brain, the existence of a posterior cornu in the lateral ventricles, and the presence of a hippocampus minor in the posterior cornu,—in a distinct subkingdom, which he had called Archencephala, between which and the other members of the class Mammalia the distinctions were very marked, and the rise was a very abrupt one."

We know not whether Professor Owen availed himself of the cast of the Gorilla's brain, not merely to confirm a previous argument, but specially to invite the renewal of an old controversy; however this might be, in the assembly he addressed he must certainly have anticipated opposition, and this was offered with less of moderation and respectful consideration than a sense of decorum seemed to demand. We refer especially to the remarks of Professor Rolleston, though Professor Huxley's observations had enough of vehemence. He commenced with a very just remark that "the question was partly one of facts, and partly one of reasoning." The question of fact was, what are the structural differences between man and the highest apes? The question of reasoning, what is the systematic value of those differences?" But there are difficulties here. A large proportion of those who are interested in such inquiries, and know how to appreciate evidence brought before them, have never, or very seldom, had the opportunity of examining the brain of any monkey, or even in favourable cases have seen for themselves a very small variety. They must, therefore, receive the facts from others, and if those on whose knowledge, skill, experience, and intention to make known the truth they most rely, flatly contradict one another on the most essential points, what becomes of the foundations of their belief, or with what advantage can they proceed to reason on the application of facts themselves altogether uncertain?

Here is Professor Huxley's statement as reported: "Professor Owen had made three distinct assertions respecting the differences which obtained between the brain of man and that of the highest apes. He asserted that three structures were 'peculiar to and characteristic' of man's brain—these being the 'posterior lobe,' the 'posterior cornu,' and the 'hippocampus minor.' In a controversy which had lasted for some years, Professor Owen had not qualified these assertions, but had repeatedly reiterated them. He, (Professor Huxley) on the other hand, had controverted these statements; and affirmed, on the contrary, that the three structures mentioned not only exist, but are often better developed than in man, in all the higher apes. He now appealed to the anatomists present in the section, whether the universal voice of continental and British anatomists had not entirely borne out his statements and refuted those of Professor Owen."

This is very strong language. As to certain anatomists present, no doubt the learned professor knew that he could rely upon them to support his views, but we are exceedingly mistaken if their verdict would be confirmed by the great body of those conversant with the facts. At all events, those who are obliged to take their data from others find, in this case, that, respecting matters of fact, two of the very highest authorities are directly opposed; and upon what are they to rely? They may, indeed, remember, as accounting in some degree for the different perceptions of the observers, that Professer Owen believes in the reality and permanence of species, and regards the various degrees of development of the nervous system as likely to furnish the most important of all characters; whilst Professor Huxley warmly defends the Darwinian theory respecting the origin and changes of species, and professes to regard the superiority of man to other animals as independent of structural differences. The former, in studying the brains of the animals nearest to man, would be watchful for good distinguishing characters, and acutely sensible to any which presented themselves: the latter would look at the same objects to search for analogies, and to find out the course of transition from one structure to another. We cannot but think that much of the difference in this case is, not as to what is actually seen, but as to the importance and real meaning of the appearances; and we must add that Professor Owen's view is strikingly confirmed by the gradations in the Mammalian brain throughout the lower forms, the extension of the cerebral hemisphere anteriorly, and still more manifestly posteriorly, being the invariable accompaniment of every elevation of structure.

Professor Rolleston, in professing to specify the real differences between the brain of man and that of the apes, which he accused Owen of neglecting, points out, from Gratiolet, striking particulars of real importance, though not what Owen had taken for the character of his Archencephala, but the assumption that Owen was ignorant of or neglected these particulars because they did not enter into his differential character, for which purpose they were not well suited, is most unfair. The presence of gyrations on the brain is assumed by him as the distinction of his second great division, being thus taken as a sign of more advanced development than when these gyrations are absent, the natural conclusion being that they would be still more fully developed in the higher division. And this was even expressly stated by Owen, as in his Cambridge lecture, in 1859, where he concludes his character of the Archencephala in these words: "The superficial grey matter of the cerebrum, *through the number and depth of the convolutions*, attains its maximum of extent in Man." Besides all this Professor Owen was able to repel the charge of overlooking this peculiarity by referring to his lectures on the convolutions of the brain, delivered "almost at the very time when Leunet wrote his memoir on the subject," and the diagrams of which are still in the Museum of the Royal College of Surgeons. Without neglecting or undervaluing other accompanying signs of higher development, which all confirm his view, Professor Owen took the posterior enlargement of the cerebral hemispheres so as to cover the cerebellum, with the other characters above noted in connexion with this, as forming the best technical distinction of that highest Mammalian group which he named Archencephala. He insists on the reality of the character and contends for its importance. As to the matter of fact, with directly opposing testimony where wilful falsehood cannot be attributed to either party, it is not always easy to find out the truth, but the deliberate assertion of one of the ablest observers and perhaps the most experienced of his time, supported by figures professing to be carefully taken from nature must have great weight, and it seems probable that the counter-statements of some very eminent men are due rather to difference of expression and interpretation than of simple fact.

Taking a general view of the whole subject it is antecedently probable that the comparative development of the brain should furnish the most important characters and no one can reasonably doubt the practical result of Owen's system being a great improvement in the natural arrangement of Mammalia. In the case of the Lyencephala the peculiar character of the brain corresponds with a lower type of the reproductive system and the section is unquestionably natural. In respect to Gyrencephala and Lissencephala the difference in the character of the brain is very striking and the groups thus associated are felt to be natural, nor are the exceptions more numerous on either side than are always to be expected in the way of special modifications and transition forms where we are obliged to place objects according to their affinities, though departing from technical characters. Now we are none of us perhaps disposed to consider the difference between man and the highest Gyrencephala as less than that between these and the Lissencephala. In some way we feel sure that the human race is elevated above all other creatures, and as in all other known instances superiority is connected with special development of the brain, that is what we have to expect here; as in other instances the enlargement forward, backward, and by gyrations of the cerebral hemispheres is the test of elevation of structure, so here it is what we are led to expect. We know that in the human brain, even in the lowest varieties of our race, the posterior cerebral lobes cover and even pass beyond the cerebellum. We are assured that even in the highest section of the Quadrumana, which must be admitted to be on the whole nearest in structure to man, this is never the case. We have thus a character drawn from the structure of the brain, confirmatory of all other reasons for assigning to man that elevation in a Zoological system which in other ways we know him to possess, and it is really easier to suppose that some ingenious and able men are led away by theoretical prepossessions in their mode of estimating and expressing what they see than to question the direct testimony of one who has done more for the comparative and theoretical anatomy of the Vertebrate sub-kingdom than any of his contemporaries and has himself dissected the brain of at least one species in nearly every genus of Mammals, when what he tells us is probable in itself and agrees with many important statements by others. Until we obtain better evidence we must for ourselves adhere to Owen's views and believe the facts he records. Some of our readers may have smiled at Charles Kingsley's witty application of the Darwinian theory in his Fairy tale of the Water babies. His moral is an excellent one, but neither men passing into apes, nor apes passing into men, accord with our ideas of the position given us by our Creator. We cherish the belief in an essential and permanent structural distinction, and Owen's account of its nature, if not true, is very plausible, and is certainly not yet shewn to be false.

W. H.

AURORAL ARCH OF APRIL 9TH.

A very remarkable auroral phenomenon was recorded at the Magnetic observatory, Toronto, on the night of April 9th.

About 8 P.M. a bright luminous band of extraordinary brilliancy was observed extending from E.S.E. to W.S.W. through or a little to the South of the zenith. The band was at first stationary with an uniform width of about 3° or 4° and with well defined edges.

At 8 30 luminous lines without any apparent movement were observed to fringe the northern edge through about 15° of its length on each side of the zenith. The fringe thus formed tapered off to points at both extremities, the width of the centre being about 7°.

At the same time the southern edge, from its eastern extremity to about 20° west of the zenith, formed the boundary of a fringe of small streamers ascending upwards from the south, and which on reaching the arch were deflected so as to form in appearance the material for the supply of a mass of luminous clouds which rolled tumultuously along the track of the band with enormous rapidity. The motion as far as the eye could judge consisted in a *transfer* of luminous matter and not as on ordinary occasions in undulations or pulsations, a circumstance constituting the chief peculiarity of this display.

From 9 to 9 30 when the arch was contracted in its length about 30° at each extremity, the rays on the northern edge had disappeared, and the streamers were limited to the eastern extremity, but there was no abatement in the mass or velocity of the luminous torrent. The arch then became irregular in its form; by 9 40 it had disappeared, but returned again in a less developed state and continued from about midnight till 2 A.M., when it ceased.

A magnetic disturbance was going on during the earlier part of the display, which ceased with the departure of the arch and recommenced with its reappearance. The extent of the disturbance, in harmony with what commonly occurs during the presence of bands at right angles to the magnetic meridian, was much less than in the case of auroral movements emanating from the north.

The Rev. Vincent Clementi of Peterborough writes that the arch as seen by him appeared first in the north, simultaneously with and apparently forming part of the aurora; that it disconnected itself with the aurora and passed onward with great rapidity until it crossed the zenith, where it remained stationary in the south stretching eastward and westward, streamers or rays breaking from it through the whole extent of its southern edge. The form of the band according to a sketch which he has kindly forwarded was not precisely the same as that seen at Toronto being much wider at the centre and converging to a point at both extremities, with a secondary band with its western extremity coinciding with that of the primary and with its eastern extremity immediately under its centre. He further states that the arch was of such extreme tenuity that stars shone through it with seemingly no diminution of their brilliancy.

The chief points of difference between the phenomena at the two places consist in the tenuity of the luminous matter as seen at Peterborough, the circumstance that there the streamers proceeded *from* instead of *into* the arch, as at Toronto, and that Mr. Clementi makes no mention of the apparent transfer of the luminous matter which here formed the chief peculiarity.

Luminous arches extending through the zenith in a direction perpendicular to the meridian, though not an ordinary accompaniment of the aurora, have been noticed before at Toronto and elsewhere, though rarely attended with the peculiar appearances which marked the display of April 9th.

G. T. K.

NOTE ON THE SPECIES MONOHAMMUS.

To the Editor of the Canadian Naturalist.

In the December number of the *Canadian Naturalist* Mr. Billings has described some of the pine-boring beetles of Canada, of the genus *Monohammus*, and mentions that the *M. titillator* is cited by Mr. Couper and Mr. Ibbetson as occurring at Toronto, but is of opinion that the insect described is the *M. confusor*.

I can confirm this idea of Mr. Billings, as the insects in my own collection and in that of Mr. Ibbetson were named on reference to Harris' work. The description agrees very closely with the reddish brown specimens mentioned by Mr. Billings as having been obtained from Toronto, where from my own observations they seem to be much more common than those of a cinereous tint.

Moreover the drawing of *Monohammus titillator* in Olivier's work agrees very well with these specimens. Those in my collection are mostly of the same size as the *M. confusor* and generally a little more robust, but are probably only a variety. The *M. scutillatus* is moderately common about Toronto, but the *M. marmoratus* quite rare; the latter easily distinguished by its smaller size, its rugosely punctured thorax, and the elytra mottled with brown and grey.

In my collection there is also a crippled specimen very like *M. scutillatus* but the elytra are covered with large white spots, in this respect resembling Leconte's *M. fatuor*, which however is now referred to *M. marmoratus*.

In the recent edition of Harris' work the name *titillator* is still employed.

H. C.

ON GROUND-ICE, OR ANCHOR ICE, IN RIVERS.

BY PROFESSOR JAMES THOMPSON.

In this paper the author described the two principal modes of growth of ice, in still water and in running water. In still or slowly moving water the ice forms itself as a crust on the surface, because, as the water cools from about

40° F. down to the freezing-point, it expands, and therefore becomes lighter, and remains floating at the surface, and then, on freezing there, it expands still further, and therefore still more tends to float. In rapidly-moving river water, on the contrary, and especially at the foot of rapids, ice is often found to grow attaching itself to the rocks or stones forming the bed of the river, as a spongy or porous mass, which, seen in the aggregate and not examined minutely, presents a general appearance not unlike the spawn of frogs. In large rivers in cold climates, as, for instance, in the St. Lawrence, immense quantities of this ice, called ground or anchor ice, are found to accumulate with astonishing rapidity. These accumulations of ice, by damming up the water, cause great floods, and by yielding to the force of the water, and moving down with the current, especially after they have become jammed and heaped up with other ice formed on the surface, act in producing very striking geological effects in disturbing the bottom and banks of the river, and in shoving along huge boulders which otherwise would remain immoveable. The ground and surface-ice also, by their shoving-action, introduce formidable difficulties and dangers in the construction of bridges or other engineering works requiring to be founded on the beds of rivers in cold climates. In the construction of the Great Victoria Bridge across the St. Lawrence at Montreal (the most costly bridge which has ever been executed), these difficulties have been successfully overcome, and a structure has been raised which is likely to stand secure against the much-dreaded forces of the ice. On account of the tendency both of water approaching to the freezing-point and of ice to float, it has long been regarded as rather a singular circumstance that ice should ever be found growing at the bottom of a river. From among the many suggestions which have been offered at various times to account more or less completely for the phenomenon, the author sets out by accepting as quite correct the view that the essential difference between the circumstances of the freezing of lake and river water is, that in the former case the water is left undisturbed to the action of the cold, and is allowed to adjust itself in strata in which the coldest parts, being also the lightest, float to the top; while in rivers the whole water is, by mixing, due to its rapid flow, brought to an uniform temperature at the freezing-point from top to bottom, and is thus brought into a condition in which it is ready to freeze at any part where additional cold may be applied. He is not, however, satisfied with any of the numerous suggestions which have been offered to account for the growth of the masses of spongy ice at the bottom, rather than that the ice should be found at the top, or in a state of mixtnre with the water throughout its depth. Some, for instance, have thought that radiation from the bottom to a cold sky (see paper by the Rev. James Farquharson, Philosophical Transactions, 1835) would cause ice to grow at the bottom of the river much in the same way as hoar-frost grows on land. Arago, having rejected the supposition of radiation being the cause, assigned two other reasons: first, that there might be expected to be a peculiar aptitude to the formation of crystals on the stones and asperities at the bottom, like as there is found to be a special readiness for the formation of crystals on rough bodies in saline solutions; and secondly, he supposed that the existence of less motion of the water at the bottom would favour the growth of the crystals there. As against this view, the author of the present paper states, first, that the water of a rapid river when freezing has abundance of small spicula or fragments of ice floating diffused through it, every one of which offers at least as free a point for the reception of new ice crystallizing from the water as can be presented by asperities on the bottom; and secondly, that the slower motion at the bottom would not favour the occurrence of freezing of new ice there rather than at the top, but that, on the contrary, if effects on the tendency to crystallization are to be sought for in such a slight cause, it should rather be taken that the greater fluid friction at the bottom, and the heavier pressure there, are causes slightly, *but certainly very slightly*, tending to oppose the freezing of new ice at the bottom.

Mr. Hodges, the engineer of the contractors for the great bridge across the St. Lawrence at Montreal, in his large and valuable work recently published (in 1860) on the construction of that bridge, describes the ice-phenomena of the St. Lawrence, which he had been obliged during many years to watch and inquire into with anxious care; and in respect to the origin of the ground-ice, he supposes that the water in passing down rapids may become aerated by the rapidity of the current, and that particles or globules of cold air, being whirled by the eddies till they come in contact with the rocky bed of the river, attach themselves to it, and there give out cold which they have brought with them from the very cold atmosphere above, and so induce the freezing of ice around themselves in adhesion to the bottom of the river. As against this speculation, the author of the present paper states that the cold which could be conveyed down into the water by small bubbles would be totally inadequate to produce the results in question, and that any freezing which small bubbles of air could produce would occur during the period of their eddying about through the water, rather than at a later time, when their temperature would be assimilated to that of the water. The author's view, which it was the chief object of the paper to present, is that crystals or small pieces of ice are frozen from the water at any part of the depth of the stream, whether the top, the middle, or the bottom, where cold may be introduced either by contact or radiation, and that they may be supplied in part by snow or otherwise; and that they are whirled about in currents and eddies until they come in contact with any fixed objects to which they can adhere, and which may perhaps be rocks or stones, or may be pieces of ice accidentally caught in crevices of the rocks or stones, or may be ground-ice already grown from such a beginning. The growth of the ice by adhesion of new particles formed elsewhere he attributes to the property of any two pieces of moist ice to adhere when brought into contact, which has been a subject of much discussion of late years, and of which the author's views are to be found in various recent papers in the 'Proceedings of the Royal Society,' and have also been submitted from time to time to the Belfast Natural History and Philosophical Society. He is confident that the anchor ice is not formed by crystallization at the place where it is found adhering. He is aware that the idea has sometimes been mooted, that snow falling into rivers might somehow be converted into anchor ice; but he is not aware that hitherto any explanation has been offered coupling the formation of the anchor ice with the property of ice now commonly designated as "regelation," but which until late years was not very generally known or understood, more especially as a property capable of bringing about the union of small pieces of ice floating freely under water: and the mode of growth of ground-ice is, he believes, as yet commonly regarded as an unsettled point, no opinion offered having received very decisive or general assent.—*Proceedings of the Belfast Natural History and Philosophical Society*, May 7, 1862.

DRY COLLODION PROCESS IN PHOTOGRAPHY.

Mr. Sutton claims to have discovered a process with dry plates which gives all the rapidity and keeping properties of the well-known trade secret of Dr. Hill Norris. The following account is extracted from the "Photographic Notes" Oct. 15, 1862.

The problem which has most interested photographers of late years has been the discovery of a dry collodion process, by which plates can be prepared as sensitive as with wet collodion. In the wet process the negative has to be taken and finished upon or near the spot from which the view is taken, and with wet collodion the tourist is therefore obliged to work in a van or tent, and carry a load of paraphernalia about with him, which is of course both expensive and inconvenient. To avoid this he is compelled to work with dry plates, and hitherto no process has been published by which dry plates can be made as sensitive as wet ones. A rapid dry process has therefore been an important subject of investigation to photographers, because during a long exposure of a plate the shadows move, and figures sometimes alter their position. A man or horse, for instance, are likely to remain still for a few seconds, but not for ten minutes.

I have lately solved this problem of rapid dry collodion, and produced dry plates as sensitive as wet ones, which will moreover preserve their sensitiveness and good qualities for several weeks, and perhaps indefinitely. This process, and the principles upon which it is based, I will now briefly describe.

The rapidity of this dry process depends upon the accelerating effect of bromine in dry collodion, and in this respect an anology exists between the Daguerreotype and dry collodion processes. In the former a silver plate simply iodized is extremely insensitive, but when submitted to the fumes of bromine its sensitiveness is increased a hundred-fold. The same thing happens in those collodion processes, wet or dry, in which the free nitrate of silver is washed out of the film. A collodion film simply iodized, and without free nitrate, is as insensitive as an iodized Daguerreotype plate, but a bromo-iodized collodion film without free nitrate may be rendered as sensitive as a bromo-iodized silver plate. In the wet collodion process the most exalted sensibility is conferred upon a simply iodized film by the presence of free nitrate of silver; but you cannot retain free nitrate in a dry collodion film because it not only crystallizes on drying, but by becoming concentrated as the water evaporates, dissolves the iodide of silver, and forms a curious and interesting double salt, the exact properties of which have not yet been fully investigated. You cannot even retain a perceptible trace of free nitrate entangled in a dry collodion film without introducing an element of instability, and consequent uncertainty in your work. The principle therefore of preparing a rapid dry collodion plate consists in using bromo-iodized collodion, and removing all the free nitrate, which is the element of instability.

But the image produced upon a bromo-iodized silver plate, developed with mercury, is extremely thin and superficial, as may be proved by transferring it to a sheet of gelatinized paper. And similarly, the image developed by pyrogallic acid upon a dry bromo-iodized collodion film is thin, and too transparent to yield a good printing negative. It is necessary therefore to apply to the film a coating of some organic substance, in order to give density to the dark parts of the negative. Many substances have been employed for this purpose, viz., gelatine, metagelatine, albumen, various syrups, gum arabic, infusion of malt, tannin, &c., &c.; and experimenters have, almost without exception, exhausted their ingenuity in varying these preservative coatings, as they are called, instead of seeking in the use of bromide for the true accelerating agent. The preservatives named have not all the same effect, and besides affecting the sensitiveness of the film they also determine the color of the finished negative, gelatine and gum giving a black, tannin a red, and albumen a yellowish color to the deposit in the dark parts. Much therefore depends upon the selection of a proper preservative, when the most exalted sensitiveness is required.

One more difficulty remained to be overcome, and it is this. When a collodion film has once been allowed to get dry, and is wetted a second time, it is very liable to split and leave the glass; or if a preservative has been applied to it, it is very liable to rise in blisters, which spoil the negative. But this may be prevented by giving the glass plate a preliminary coating of india-rubber dissolved in Kerosolene.

The operations in the rapid dry process are therefore as follows:—

1. Clean the glass plate, dry it thoroughly, and apply to it a solution composed of 1-gr. of india-rubber dissolved in an ounce of Kerosolene.

2. Coat the plate thus prepared with bromo-iodized collodion containing an equal number of atoms of iodine and bromine, added in combination with cadmium. There should be about 5-grs. of mixed iodide and bromide of cadmium to the ounce of collodion.

3. Excite the film in a bath composed of 30-grs. of pure recrystallized nitrate of silver, slightly acidified with nitric acid.

4. Wash off all the free nitrate of silver, and pour over the film a preservative composed of 25-grs. of gum arabic freshly dissolved in an ounce of water. Let it dry spontaneously, and before putting the plate into the dark slide, dry it again thoroughly before a hot flat iron.

5. Give the same exposure as for wet collodion.

6. Develope the picture by first wetting it with distilled water, and then pouring over it a developer consisting of 1-oz. of distilled water, 2-grs. of pyrogallic acid, 2 scruples of glacial acetic acid, and a few drops of a weak solution of nitrate of silver. The image appears immediately, and very soon acquires the necessary intensity.

7. Fix the negative in the usual way with a saturated solution of the hyposulphite of soda or lime, and when dry varnish it with spirit varnish.

Negatives taken in this way are equal in every respect to those taken upon wet collodion plates, and the process is as simple as any of those which are now employed for slow dry plates.

MONTHLY METEOROLOGICAL REGISTER, AT THE PROVINCIAL MAGNETICAL OBSERVATORY, TORONTO, CANADA WEST,—APRIL, 1863.

Latitude—43 deg. 39.4 min. North. Longitude—5 h. 17 min. 33 sec. West. Elevation above Lake Ontario, 108 feet.

Day.	Barom. at temp. of 32°.				Temp. of the Air.				Excess of mean above Normal.	Tens. of Vapour.				Humidity of Air.				Direction of Wind.			Resultant Direction.	Velocity of Wind.					Rain in Inches.	Snow in Inches.
	6 A.M.	2 P.M.	10 P.M.	MEAN.	6 A.M	2 P.M.	10 PM	ME'N		6 A.M	2 P.M.	10 P.M.	M'N	6 A.M	2 P.M.	10 P.M.	M'N	6 A.M.	2 P.M.	10 P.M.		6 A.M	2 P.M	10 PM	Resul't.	ME'N		
1	29.564	29.423	29.153	29.3428	°8.9	°24.8	°30.6	°22.27	°−13.97	.049	.105	.152	.101	.75	.79	.89	.78	N N W	S W	S S W	S 56° W	17.0	13.0	12.5	9.93	12.64	...	0.1
2	28.704	28.903	.298	28.9915	38.8	41.0	32.0	37.17	+ 0.53	.222	.127	.151	.159	.94	.47	.83	.72	W S W	N W b W	N W b W	N 59 W	6.0	29.8	6.4	14.02	15.36	...	0.1
3	29.504	29.750	—	—	29.5	35.2	—	—	—	.136	.135	—	—	.83	.66	—	—	N	N b W	N b W	N 9 W	6.5	11.8	19.0	11.77	12.17	..	...
4	30.041	.994	.857	29.9657	21.2	33.4	27.3	28.30	− 9.03	.092	.089	.127	.103	.81	.47	.84	.68	N N E	S E	N N W	N 19 E	5.0	9.2	3.8	2.66	6.27	...	..
5	29.696	.483	—	—	26.6	46.8	—	—	—	.098	.083	—	—	.68	.25	—	—	N	N W	W b N	N 31 W	12.4	19.8	0.5	10.24	10.46	...	...
6	.384	.442	.592	.4840	34.5	43.5	31.6	36.38	− 1.65	.174	.135	.163	.162	.87	.46	.91	.77	N N W	N E b N	N b E	N 5 E	2.8	6.4	13.0	11.95	12.35	0.060	1.2
7	.676	.789	.927	.8097	26.6	31.5	30.6	29.68	− 8.73	.134	.142	.138	.136	.93	.79	.80	.83	N b E	N b W	N	N 1 W	16.0	11.0	7.2	9.35	9.55	...	0.2
8	.930	.895	.891	.9043	30.2	34.2	32.7	32.60	− 6.12	.149	.152	.165	.150	.89	.77	.88	.81	N b E	S W	N W	N 35 W	4.8	7.8	7.8	4.62	6.96	...	...
9	.901	.882	.845	.8763	31.6	45.7	33.4	37.10	− 1.93	.111	.148	.149	.137	.62	.47	.78	.63	N W b N	S S W	S W	S 67 W	11.0	12.0	3.5	4.38	7.32	...	...
10	.784	.558	.489	.5967	31.3	43.9	41.4	39.52	+ 0.10	.152	.190	.241	.192	.86	.66	.92	.78	S S W	E	Calm.	N 82 E	1.3	5.0	0.0	2.87	3.40	0.035	...
11	.420	.369	.430	.3938	40.7	60.0	48.9	50.18	+10.45	.231	.301	.288	.278	.91	.57	.83	.77	N E b N	S W b S	W	S 59 W	1.5	17.0	3.5	8.69	10.25	0.585	...
12	.471	.662	—	—	43.2	39.9	—	—	—	.209	.163	—	—	.74	.66	—	—	W b N	N N W	N N W	N 29 W	12.3	16.8	8.0	14.29	14.78	...	...
13	.851	.847	.824	.8468	30.2	39.6	31.3	34.28	− 6.15	.136	.167	.136	.143	.80	.68	.77	.72	N b E	S S W	S W b S	S	5.8	5.0	1.0	1.48	4.02	...	...
14	.842	.814	.739	.7968	30.9	47.2	41.7	41.32	+ 0.58	157	.076	.088	.114	.90	.23	.32	.47	N b W	E b S	E N E	N 80 E	2.5	10.0	8.8	7.50	8.17	...	...
15	.694	.666	.692	.6865	40.3	49.0	43.2	44.33	+ 3.28	.166	.178	.198	.183	.66	.50	.70	.63	E b N	E N E	E	N 77 E	12.2	13.5	5.0	10.31	10.40	0.155	...
16	.678	.646	.640	.6518	40.3	45.0	44.6	43.25	+ 1.77	.219	.278	.264	.251	.87	.93	.90	.89	E N E	E b N	N E	N 51 E	18.0	10.5	13.2	10.67	11.30	0.520	...
17	.611	.627	.661	.6340	42.1	44.6	41.4	42.82	+ 1.07	.268	.283	.241	.261	1.00	.96	.92	.95	N	E S E	W S W	N 74 E	8.5	4.8	1.8	1.60	3.58	0.020	...
18	.700	.704	.682	.6933	39.4	49.7	42.5	44.13	+ 2.07	.230	.255	.236	.243	.95	.71	.86	.84	W S W	S b E	E b S	S 72 E	3.2	3.8	0.5	2.49	4.01	...	...
19	.652	.673	—	—	43.9	52.6	—	—	—	.254	.239	—	—	.89	.60	—	—	E b N	E	E b N	N 84 E	10.5	16.0	7.5	11.99	12.12	...	...
20	.681	.832	.935	.8255	50.4	39.0	39.9	42.67	− 0.12	.248	.222	.233	.231	.67	.91	.95	.85	E b N	E	E b N	N 85 E	14.5	9.2	10.2	10.69	11.07	0.835	...
21	.990	.986	.887	.9575	42.1	45.4	48.2	45.23	+ 2.13	.259	.234	.245	.241	.96	.77	.72	.80	N E b E	E N E	E b N	N 78 E	9.0	12.5	13.0	11.06	11.20	Inp.	...
22	.912	.808	.705	.7997	42.5	54.4	51.5	49.63	+ 6.27	.227	.163	.126	.172	.83	.38	.33	.50	E b S	E b N	E b N	N 77 E	9.0	18.0	11.0	11.77	11.94	...	...
23	.639	.557	.514	.5608	46.4	54.4	50.0	50.87	+ 7.17	.166	.136	.192	.164	.52	.32	.53	.44	E N E	E	N N W	N 70 E	9.0	11.5	4.5	5.26	6.16	...	...
24	.444	.344	.515	.4327	43.5	67.7	46.1	54.07	+10.07	.186	.201	.216	.208	.66	.29	.69	.52	W N W	N N W	N	N 16 W	1.8	22.4	17.0	15.02	15.72	...	...
25	.636	.657	.722	.6818	33.8	47.5	39.6	40.35	− 4.05	.099	.090	.083	.097	.50	.27	.34	.39	N	N N W	N N W	N 20 W	19.0	20.6	13.0	17.49	17.77	...	...
26	.800	.759	—	—	36.0	56.5	—	—	—	.104	.107	—	—	.48	.23	—	—	N N W	N W b N	N W b N	N 27 W	8.5	15.0	3.0	8.18	8.45	...	...
27	.735	.631	.562	.6343	38.5	60.5	41.7	49.67	+ 4.65	.129	.156	.218	.176	.55	.29	.82	.52	N W	S b W	S S W	S 35 W	2.4	8.5	0.5	3.08	4.29	...	...
28	.525	.454	.482	.4827	43.5	61.2	52.2	53.63	+ 8.23	.177	.187	.337	.245	.62	.34	.86	.61	N b W	S	E	S 87 E	1.7	3.0	8.8	3.34	5.01	...	...
29	.518	.455	.486	.4828	43.2	50.8	46.1	47.95	+ 2.22	.209	.222	.225	.212	.74	.59	.72	.63	N b E	S b E	W N W	N 83 E	5.5	5.8	1.5	2.03	4.52	...	...
30	.575	.614	.609	.6013	49.3	57.2	50.0	53.40	+ 7.35	.138	.189	.164	.177	.38	.40	.45	.42	N E b N	S b E	N W b N	S 78 E	7.0	5.2	4.8	1.82	4.89	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
M	29.6574	29.6359	29.6455	29.6453	36.81	46.85	40.74	42.03	+ 1.04	.173	.177	.191	.181	.77	.56	.74	.68	....	....	....	....	8.16	11.83	7.01	....	9.20	2.210	1.6

REMARKS ON TORONTO METEOROLOGICAL REGISTER FOR APRIL, 1863.

Highest Barometer..........................30.078 at 8 a. m. on 4th } Monthly range =
Lowest Barometer ....28.704 at 6 a. m. on 2nd } 1.374 inches.

Self-regist'ing Thermom.
Maximum Temperature .... 69°0 on p.m. of 24th } Monthly range=
Minimum Temperature .... 8°6 on a.m. of 1st } 60°4
Mean maximum Temperature .... 49°99 } Mean daily range=
Mean minimum Temperature .... 33°42 } 16°57
Greatest daily range ...... 30°05 from a.m. to p.m. of 27th.
Least daily range............ 4°4 from a.m. to p.m. of 17th.

Warmest day......... 24th... Mean temperature......... 54°07 } Difference = 31°80.
Coldest day .... 1st... Mean temperature......... 22°27 }
Maximum { Solar.................................. 93°8 on p.m. of 24th } Monthly range =
Radiation. { Terrestrial....................... —10°8 on a.m. of 1st } 104°6
Aurora observed on 5 nights, viz.,—8th, 9th, 12th, 19th, and 21st.
Possible to see Aurora on 19 nights; impossible on 11 nights.
Snowing on 4 days, depth 1.6 inches; duration of fall, 18.7 hours.
Raining on 8 days, depth 2.210 inches; duration of fall 56.5 hours.
Mean of cloudiness = 0.54. Below average 0.04.
Most cloudy hour observed, 2 p.m: mean = 0.58; least cloudy hour observed, 10 p.m.; mean, = 0.50.

Sums of the components of the Atmospheric Current, expressed in miles.

North.	South.	East.	West.
3450.18	827.37	2355.20	1712.09

Resultant direction N. 14° E.; Resultant velocity 3.75 miles per hour.
Mean velocity ....9.20 miles per hour.
Maximum velocity .... 35.2 miles, from 1 to 2 p.m. of 2nd.
Most windy day......25th...........Mean velocity, 17.77 miles per hour. } Difference=
Least windy day......10th...........Mean velocity, 3.40 ditto. } 14.37 miles.
Most windy hour ...1 p.m. to 2 p.m.........Mean velocity, 12.26 ditto. } Difference=
Least windy hour...10 p.m. to 11 p.m.........Mean velocity 6.48 ditto. } 5.78 miles.

1st. Very cold day; slight snow 1 to 4 p.m. Wind high and keen; lunar halo at midnight.—8th. Auroral light 10 p.m. and midnight.—9th. Beautiful arch of auroral light extending across zenith from W.N.W. to E.S.E., from 8 to 9.40 p.m. A few streamers occasionally till 1 a.m. of 10th.—11th. Sheet lightning 7 to 8 p.m. Thunderstorm and heavy rain 8.30 to 9.30 p.m. (first of season.) Butterflies seen.—12th. Faint Auroral light at midnight.—14th. Solar halo during the evening.—17th. Frogs croaking loudly at night.—18th. Fog 6 to 8 a.m.; wild pigeons observed.—19th. Swallows observed; faint auroral light at 9 p.m.—21st. Fog 6 and 8 a.m.; auroral light and streamers 8 and 9 p.m.—25th. Ice on exposed shallow vessels at 6 a.m.; wind high and keen.—26th. Ice on shallow vessels at 27th. Hoar frost at 6 a.m.—28th. Lunar halo at 8 and 10 p.m.—29th. Solar halo 11 a.m. and 2 p.m.; lunar halo 10 p.m.

April, 1863, was comparatively warm, dry, windy and clear.

COMPARATIVE TABLE FOR APRIL.

YEAR.	TEMPERATURE.					RAIN.		SNOW.		WIND.		
	Mean.	Excess above aver'ge (30.1)	Max. observed.	Min. observed.	Range.	No. of days.	Inches	No. of days.	Inches	Resultant. Direction.	Resultant. V'y.	Mean Force or Velocity.
1840	°42.4	+ °1.4	°65.9	°25.3	°40.6	14	3.420	2	...	...	...	....
1841	39.2	— 1.8	62.9	22.1	40.8	3	1.370	3	...	...	...	0.51 lbs.
1842	43.1	+ 2.1	89.5	21.6	67.9	8	3.740	2	...	...	...	0.57
1843	40.9	— 0.1	70.0	15.1	54.9	7	3.185	3	0.1	...	...	0.46
1844	47.5	+ 6.5	74.5	17.2	57.3	10	1.515	1	Inp.	...	...	0.24
1845	42.1	+ 1.1	66.0	14.8	51.2	11	3.290	4	1.5	...	...	1.00
1846	44.0	+ 3.0	79.4	24.4	55.0	10	1.300	2	1.3	...	...	0.55
1847	39.2	— 1.8	65.6	8.4	57.2	8	2.870	2	4.0	....	...	0.59
1848	41.3	+ 0.3	65.4	26.5	38.9	5	1.455	1	0.5	N 77° W	1.46	4.89mls.
1849	39.0	— 2.0	70.9	23.2	47.7	10	2.655	2	1.7	N 43° W	3.14	7.50
1850	37.9	— 3.1	63.2	18.2	45.0	7	4.720	2	1.1	N 39° W	1.12	7.64
1851	41.3	+ 0.3	59.2	25.8	33.4	11	2.295	3	1.2	N 14° E	2.52	8.07
1852	38.2	— 2.8	53.8	19.8	34.0	6	1.990	4	9.4	N 23° E	2.44	6.68
1853	41.9	+ 0.9	65.7	27.0	38.7	10	2.625	1	1.0	N 12° W	1.95	5.20
1854	41.0	0.0	65.1	22.3	42.8	12	2.685	4	2.7	N 50° E	2.57	6.81
1855	42.4	+ 1.4	63.8	12.2	51.6	8	2.030	3	1.6	N 36° W	3.99	7.57
1856	42.3	+ 1.3	69.8	15.1	54.7	13	2.780	3	0.1	N 29° E	1.64	6.05
1857	35.4	— 5.6	51.9	10.0	41.9	10	1.755	11	12.9	N 60° W	4.15	10.24
1858	41.5	+ 0.5	61.5	23.8	37.7	13	1.642	2	0.1	N 14° W	1.64	9.57
1859	39.5	— 1.5	62.1	23.9	38.2	9	2.527	8	1.2	N 36° W	2.33	10.79
1860	39.5	— 1.5	60.7	19.7	41.0	11	1.282	5	0.3	N 37° W	4.10	10.30
1861	42.0	+ 1.0	62.3	26.2	36.1	12	1.619	4	6.9	N 37° E	2.31	8.90
1862	39.6	— 1.4	64.1	20.1	44.0	10	2.235	4	0.2	N 50° E	2.48	9.77
1863	42.0	+ 1.0	67.7	8.9	58.8	8	2.210	4	1.6	N 14° E	3.75	9.20
Results to 1861.	40.98	...	65.87	20.12	45.75	9.5	2.398	3.3	2.51	N 19° W	2.04	7.87
Exc. for 1863.	+ 1.05	...	+ 1.83	— 11.22	+ 13.05	— 1.5	— 0.188	+ 0.7	— 0.91	....	......	+ 1.33.

MONTHLY METEOROLOGICAL REGISTER, AT THE PROVINCIAL MAGNETICAL OBSERVATORY, TORONTO, CANADA WEST,—MAY, 1863.

Latitude—43 deg. 39.4 min. North. Longitude—5 h. 17 m. 33 s. West. Elevation above Lake Ontario, 108 feet.

Day.	Barom. at temp. of 32°.				Temp. of the Air.				Excess of mean above Normal.	Tens. of Vapour.				Humidity of Air.				Direction of Wind.			Resul't. Direction.	Velocity of Wind.					Rain in inches.	Snow in inches.
	6 A.M.	2 P.M.	10 P.M.	Mean.	6 A.M	2 P.M	10 PM	ME'N		6 A.M	2 P.M.	10 P.M.	M'N	6 A.M	2 P.M.	10 P.M.	M'N	6 A. M.	2 P. M.	10 P. M.		6 AM.	2 PM.	10 P.M.	Re-sul't.	ME'N		
1	29 621	29.538	29.511	29.5533	43 2	63.7	47.5	52.48	+ 6.07	.154	.207	.235	.202	.54	.35	.71	.52	Calm.	s b w	w b s	s 29 w	0.0	14.8	2.0	6.16	6.77	...	...
2	.541	.655	.690	.6358	50.0	50.0	41.7	45.98	— 0.73	.184	.212	.200	.199	.50	.59	.76	.65	N N W	E S E	N E	N 62 E	7.4	9.5	4.2	5.24	7.53	...	...
3	.724	.692	—	—	38.1	43.9	—	—	—	.137	.137	—	—	.59	.47	—	—	E b N	E	E N E	N 73 E	13.5	9.8	8.0	8.11	8.28	Inp.	...
4	.572	.581	.597	.5813	43.5	49.0	42.8	44 73	— 2.68	.259	.198	.195	.219	.92	.55	.71	.74	N E b E	S E b E	S E	N 81 E	6.8	9 0	0 5	5.45	6.48	...	...
5	.618	.586	.642	.6150	41.7	40.1	38.9	40.08	— 7.65	.175	.153	.203	.171	.65	.60	.86	.69	N E b E	E b N	E	N 73 E	13.0	13.2	7.5	13.59	13.77	0.170	0.1
6	.667	.687	.671	.6783	38.5	42.1	41.4	40.35	— 7.68	.199	.204	.232	.207	.85	.76	.89	.82	E N E	E N E	N E b N	N 69 E	15.5	15.5	4.0	9.67	9.98	0.105	...
7	.627	.563	.579	.5932	40.3	52.2	45.4	46.45	— 1.97	.209	.223	.189	.208	.84	.56	.62	.66	N E b E	s b E	N b E	N 47 E	3.8	8.8	7.6	3.23	6.92	...	...
8	.614	.608	.586	.6025	46.8	57.6	47.2	51.30	+ 2.52	.253	.224	.183	.227	.79	.46	.56	.60	N	s b w	E b N	s 43 E	4.6	5.2	1.2	2.11	3.79	...	...
9	.573	.559	.589	.5762	46.8	64.5	52.6	55.47	+ 6.30	.216	.273	.300	.260	.67	.44	.75	.59	N E b E	s s E	w b s	s 41 w	3.0	3.0	1.0	1.59	2.18	...	...
10	.608	.567	—	—	50.0	58.0	—	—	—	.294	.359	—	—	.81	.74	—	—	Calm.	s	Calm.	s 83 w	0.0	2.5	0.0	0.33	1.35	0.098	...
11	.564	.681	.698	.6537	55.4	52.2	47.2	50.97	+ 1.07	.305	.358	.320	.322	.69	.92	.98	.87	Calm.	E b N	E b N	N 73 E	0.0	6.8	6.0	4.60	5 30	0.825	...
12	.640	.650	.685	.6610	47.5	51.1	46.4	48.93	— 1.23	.316	.352	.290	.323	.96	.94	.92	.93	E b N	E b s	s E b E	N 89 E	0.5	0.5	3.2	1.16	1.74	0.150	...
13	.689	.619	.579	.6213	47.2	59.0	49.3	52.07	+ 1.50	.300	.335	.262	.295	.92	.67	.74	.76	N b w	s	N N W	N 16 E	1.5	9.0	3.2	1.04	5.10	0.242	...
14	.558	.519	.618	.5738	46.1	50.4	47.5	48.42	— 2.47	.273	.308	.207	.259	.87	.84	.62	.76	N	NW b w	N W	N 30 W	3.8	10.5	14.0	8.41	9.65	0.533	...
15	.674	.632	.557	.6080	46.8	59.8	46.1	51.02	— 0.27	.225	.281	.153	.235	.70	.54	.48	.62	N N W	s b w	s w	s 16 w	8.6	10.8	1.5	5.05	6.66	0.030	...
16	.354	.300	.428	.3560	45.0	59.8	50.8	52.52	+ 0.93	.269	.369	.258	.305	.90	.72	.69	.77	E S E	s s w	N b w	N 82 W	7.4	6.4	12.8	3.73	9.01	Inp.	...
17	.466	.503	—	—	45.0	54.0	—	—	—	.221	.232	—	—	.74	.55	—	—	W N W	N	NW b N	N 79 W	9.0	6.6	12.0	6.47	9.75	0.045	...
18	.577	.620	.697	.6352	45.0	55.4	47.5	50.27	— 2.02	.239	.233	.245	.241	.80	.52	.74	.68	N W	W N W	W N W	N 54 W	12.0	19.0	7.2	11 21	11.49	...	...
19	.726	.641	.639	.6648	45.7	71.7	54.7	59.05	+ 6.43	.202	.310	.294	.270	.66	.40	.68	.55	W	s w b w	s w b w	s 56 w	3.4	17.4	6.0	8.93	9.28	...	...
20	.659	.669	.695	.6842	51.5	63.4	56.5	57.53	+ 4.52	.347	.404	.368	.376	.91	.69	.80	.79	s w	w s w	s w	s 54 w	6.6	15.0	3.0	4.39	4.44	0.030	...
21	.797	.843	.840	.8292	55.4	73.1	62.7	64.82	+11.50	.327	.403	.404	.378	.74	.49	.71	.62	s w b w	s s w	s w b w	s 45 w	2.2	13.0	3.8	6.19	6.90	...	...
22	.892	.824	.766	.8202	58.7	75.3	63.0	67.78	+14.08	.419	.497	.437	.443	.85	.57	.76	.67	W N W	s w b s	s w	s 60 w	1.8	7.0	0.5	2.68	3.21	...	...
23	.726	.628	.541	.6208	65.9	76.0	62.7	69.58	+15.62	.411	.445	.380	.427	.64	.50	.66	.59	NW b w	s s w	s w b s	N 84 w	3.2	4 8	0.5	1.68	2.73	...	...
24	.522	.499	—	—	63.4	73.1	—	—	—	.333	.542	—	—	.57	.65	—	—	NW b N	s s w	N b E	N 85 w	7.5	12.0	6.5	1.60	6.54	...	...
25	.582	.627	.618	.6258	56.9	58.7	54.4	56.30	+ 1.62	.329	.350	.278	.305	.71	.70	.65	.66	E	E S E	E b N	N 86 E	5.1	20.0	8.8	9.45	9.96	...	...
26	.713	.731	.737	.7317	51.5	61.2	56.2	57.02	+ 2.03	.304	.328	.339	.326	.80	.61	.75	.71	E N E	E	E b N	N 68 E	1.0	8.5	4.8	5.02	5.67	...	...
27	.810	.794	.769	.7915	55.8	69.2	52.9	59.83	+ 4.55	.322	.405	.338	.357	.72	.56	.84	.70	N N E	s b w	Calm.	s 17 w	0.5	1.5	0.0	0.19	0.33	...	...
28	.781	.711	.634	.7032	51.1	73.1	63.4	63.20	+ 7.55	.246	.431	.333	.361	.65	.52	.57	.62	Calm.	s w b s	s w b s	s 51 w	0 0	1.2	1.0	0.49	0.64	...	...
29	.604	.501	.384	.4835	56.2	70.2	59.1	64.05	+ 8.10	.360	.431	.323	.380	.80	.58	.64	.64	Calm.	s E	Calm.	N 62 E	0.0	0.5	0.0	0.41	0.51	...	...
30	.264	.148	.063	.1425	59.8	61.6	59.0	61.58	+ 5.33	.370	.519	.439	469	.72	.95	.88	.86	Calm.	E b s	s w	s 33 w	0.0	2.8	1.8	1.41	3.13	0.210	...
31	.039	.011	—	—	60.1	61.2	—	—	—	.461	.499	—	—	.89	.92	—	—	w b s	w s w	N N w	s 63 w	4.6	4.5	6.5	2.35	3.35	0.925	...
M	29.6324	29 6133	29.6093	29.6170	49.70	60 02	51.42	54.30	+ 2 82	.277	.325	.285	.299	.76	.62	.73	.69	....	....	....	....	4.72	8.68	4.49	......	5.89	3.363	0.1

REMARKS ON TORONTO METEOROLOGICAL REGISTER FOR MAY, 1863.

Highest Barometer . . . . 29.901 at 8 a.m. on 22nd. } Monthly range=
Lowest Barometer . . . . 29.011 at 2 p.m. on 31st. } 0.890 inches.

Self-registering Ther.
- Maximum temperature . . . . 79°0 on p.m. of 22nd } Monthly range=
- Minimum temperature . . . . 36°4 on a.m. of 1st } 42°6
- Mean maximum temperature . . 63°42 } Mean daily range=17°15
- Mean minimum temperature . . 46°26 }
- Greatest daily range . . . . . . 34°8 from p. m. to a. m. of 19th.
- Least daily range . . . . 3°4 from a. m. to p. m. of 11th.

Warmest day . . . 23rd...Mean Temperature . . . 69°58 } Difference=29°50.
Coldest day . . . . 5th ...Mean Temperature . . —40°08 }
Maximum { Solar . . . . 95°5 on p.m of 29th } Monthly range=
Radiation { Terrestrial . . . . 25°5 on a. m. of 17th } 70°.0
Aurora observed on 0 nights; possible to see Aurora on 18 nights; impossible on 13 nights.
Snowing on 1 day; depth 0.1 inches; duration of fall 1.0 hours.
Raining on 14 days; depth, 3.363 inches; duration of fall, 67.7 hours.
Mean of cloudiness=0.48; below average, 0.05. Most cloudy hour observed, 2 p.m; mean=0.58; least cloudy hour observed, 10 p.m.; mean=0.30.

Sums of the components of the Atmospheric Current, expressed in Miles.

North.	South.	East.	West.
1324.08	1151.42	1674.66	1419.85

Resultant direction, N. 56° E.; Resultant Velocity, 0.41 miles per hour.
Mean velocity 5.89 miles per hour.
Maximum velocity 21.8 miles, from noon to 1 p.m. on 18th.
Most windy day 5th—Mean velocity 13.77 miles per hour. } Difference 13.44.
Least windy day 27th—Mean velocity 0.33 miles per hour. }
Most windy hour, 1 to 2 p.m.—Mean velocity, 8.82 miles per hour. } Difference
Least windy hour, 5 to 6 a.m.—Mean velocity, 4.10 miles per hour. } 4.72 miles.

1st. Slight hoar frost, 6 a.m.—5th. Particles of snow, hail, and rain, 10 and 11 a.m.—13th. Distant thunder in W. at 2.45 and 3.30 p.m.—20th. Thunderstorm passing from NW. to E. at 8 a.m.—21st. Sheet lightning in SW. at 9 p.m.—28th. Corona round the moon at 9 p.m.—29th. Solar halo, 8 a.m. to 4 p.m.; very perfect lunar halo at 10 p.m.—30th. Thunderstorm, sheet and forked lightning, and heavy rain in S.W., 11 a.m. to 0.30 p.m.; slight fog 4 p.m.

Great range of temperature from a.m. to p.m. of 19th = 34°8 in 14 hours.
Heavy dew recorded on 14 mornings during the month.
May, 1863, was comparatively mild, wet, calm, and clear.

COMPARATIVE TABLE FOR MAY.

YEAR.	TEMPERATURE.					RAIN.		SNOW.		WIND.		
	Mean.	Excess above Average, (51°4).	Maximum observed.	Minimum observed.	Range.	No. of days.	Inches.	No. of days.	Inches.	Resultant. Direction.	Resultant. Velocity.	Mean Force or Velocity
1840	53°.8	+ 2.4	74°.5	30°.8	43°.7	9	4.150	0	...	...	...	...
1841	50.5	— 0.9	76.2	26.6	49.6	11	2.350	1	...	...	...	0.35 lbs
1842	49.1	— 2.3	74.3	30.0	44.3	7	1.275	0	...	...	...	0.53 "
1843	49.1	— 2.3	79.6	28.9	50.7	5	1.570	0	0.0	...	...	0.52 "
1844	53.6	+ 2.2	77.7	29.0	48.7	14	5.670	0	0.0	...	...	0.30 "
1845	49.6	— 1.8	76.6	29.4	47.2	8	2.300	0	0.0	...	...	0.55 "
1846	55.5	+ 4.1	78.1	34.3	43.8	9	4.375	0	0.0	...	...	0.46 "
1847	54.4	+ 3.0	72.5	27.8	44.7	12	2.010	0	0.0	...	...	0.29 "
1848	54.1	+ 2.7	78.5	31.9	46.6	13	2.520	0	0.0	N 40 W	1.31	4.93 ms
1849	48.0	— 3.4	72.5	32.7	39.8	16	5.115	0	0.0	N 51 E	1.97	5.33 "
1850	47.6	— 3.8	76.3	31.1	45.2	7	0.515	1	Inp.	N 64 W	2.05	6.32 "
1851	51.3	— 0.1	73.2	28.7	44.5	12	2.950	1	0.5	N 32 W	1.59	6.34 "
1852	51.4	0.0	73.3	34.5	38.8	7	1.125	1	Inp.	S 82 W	0.99	4.00 "
1853	50.9	— 0.5	78.4	38.4	40.0	17	4.420	1	Inp.	N 2 W	0.83	5.16 "
1854	52.2	+ 0.8	69.0	27.6	41.4	11	4.630	0	0.0	E	0.40	5.38 "
1855	53.1	+ 1.7	74.8	33.9	40.9	6	2.565	2	0.9	N 1 W	2.76	5.93 "
1856	50.5	— 0.9	80.1	35.5	44.6	14	4.580	1	Inp.	N 4 E	3.99	9.81 "
1857	48.9	— 2.5	72.5	27.9	44.6	15	4.145	1	Inp.	N 23 W	1.14	8.13 "
1858	48.9	— 2.5	66.0	35.0	31.0	17	6.367	0	0.0	N 42 E	3.33	9.30 "
1859	55.2	+ 3.8	76.2	41.5	34.7	11	3.410	0	0.0	N 72 E	1.59	5.70 "
1860	55.5	+ 4.1	73.2	35.6	37.6	16	1.815	0	0.0	N 26 E	2.66	7.17 "
1861	47.5	— 3.9	72.0	29.1	42.9	12	3.380	1	0.5	N 47 W	3.60	9.17 "
1862	52.2	+ 0.8	77.8	38.1	39.7	8	1.427	0	0.0	N 52 W	2.80	7.87 "
1863	54.3	+ 2.9	77.1	38.1	39.0	14	3.363	1	0.1	N 56 E	0.41	5.89 "
Results to 1861.	51.39	...	74.80	31.83	42.97	11.3	3.241	0.5	0.10	N 2 W	1.49	6.62
Exc. for 1863.	+2.91	...	+ 2.30	+ 6.27	— 3.97	+ 2.7	+ 0.122	+ 0.5	+ 0.00	...	...	—0.73

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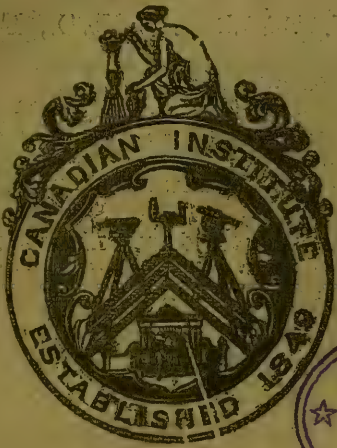

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PHONETIC ANOMALIES OBSERVED IN SOME MODERN FORMS OF ANCIENT PROPER NAMES.

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(Read before the Canadian Institute, April 18, 1863.*)*

It is generally allowed that the usual English mode of pronouncing the ancient languages of Italy and Greece is very far from being correct. However thoroughly our learned men may have entered into the genius and grammar of those tongues, the sounds which they reproduce when they come to express audibly with their lips what their eyes gather up from the written or printed page of Tacitus or Thucydides, are, probably, as like the sounds originally intended to be conveyed by the characters before them, as those uttered by the English proof-reader's assistant are, who, in ignorance of Parisian phonetic niceties, delivers aloud a chance sentence in French.

In regard to the vowel-sounds it would almost seem as if at the outset, when our forefathers,

"Teuton or Kelt, or whatever we be,"

were first made acquainted with alphabetical writing, "some one had blundered;" as if the primitive learner had confounded *a* with *e*, and *i* with *ei* or *ai;* and then that the mistakes of childhood, as is sometimes the case, had been handed on and finally become legitimized by force of custom.

We cannot imagine that Augustine and his monks, fresh from Italy, pronounced, or taught the English people to pronounce, *a*, *ay*, or *e*, *ee*, or *i*, *ei*. They would rather have represented the sound which we call *ay*, by *e* accented or unaccented; whilst the English *e* would have been written *i;* and what we call *i*, would have gone down as *ei* or *ai*.

By strangely deviating in these respects from the general usage, our nation has rendered itself doubly insular, and considerable difficulty has been thrown in the way of foreigners desiring to learn our language. Not even do our Scandinavian brethren, I believe, herein agree with us. But although the continental nations have preserved more truly than we have done the tones of the languages which we are in the practice of calling dead, we are not to imagine that this has been anything more than an accident. These nations, either occupying the ground which was formerly the area of those tongues, or being geographically in contact with it, adopted in the written and spoken developments of their own respective vernacular languages the phonetic systems of vanquished or superseded races, simply as a matter of convenience, with no particular desire to perpetuate the veritable tones of the classic tongues. Ever since the revival of literature in the beginning of the sixteenth century, there has been a school of learned men on the European continent who contend that the classic languages ought to be more completely resuscitated; that many niceties and elegances of utterance which usage in the several nations has failed to secure, might and ought to be recovered and practised.*

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* The numerous native "professors" of the Greek tongue who found their way to Italy after, and long before, the fall of Constantinople (1453), naturally pronounced the ancient language as they would their own vernacular Romaic, which bears the same relation to it that Italian does to Latin. Manuel Chrysoloras, who died in 1415, thus taught in Florence, Milan, and Rome. Previous to this, Boccacio, who died in 1375, was a diligent student of Greek under similar tuition.

Reuchlin (1455—1522) advocated the Romaic pronunciation in Germany. In 1528 Erasmus published his treatise "De rectâ Latini Græcique Sermonis pronunciatione," in which, in opposition to the great German scholar, he maintained that the ancient sounds are not reproduced by the modern modes. Henceforward there were two schools of Greek orthoepists, the Erasmian and the Reuchlinian—the *etists* and the *iotacists*, (the latter so called from their giving the sound of *iota* to η, ι, υ, and the diphthongs œ and æ.) At Oxford, Grocyn (1442—1519) taught Greek, probably *Romaicè;* and strangely enough, under him it is said that Erasmus first began the study of this language in 1497. At Cambridge, Cheke (1514—1577) inculcated a method resembling the Erasmian in his "Disputatio de Pronuncia-

In unchanged proper names, as they are read, we may say by all scholars except those of the British Islands—such as *Italia, Germanica, Roma, Terracina*—we most probably hear the words very much as Cicero or Virgil uttered them. To this day the stranger from the north, when listening to the psalms and hymns sung in the churches at Marseilles, is scarcely able to decide whether the language is Latin or Italian.

In words that have undergone a slight alteration, according to certain dialectic principles,—such as *paradiso, vino, teatro, civita, podesta*—we feel pretty sure, also, that we hear sounds and syllables of veritable Latin, as it was spoken in the villas of Italy and in the *Castra stativa* of the frontiers.

In other words and proper names that have suffered a very great metamorphosis, Latin still meets the ear, but it is Latin disguised. In the French *feu, œil,* we scarcely recognize *focus, oculus;* nor in the Italian *vescovo, chiesa, episcopus, ecclesia.* Here popular corruptions have become fixed in certain phonetic forms; orthographic we cannot style them.

Nor was rapid and vulgar pronunciation the only source of corruption. Ancient classic words suffered also from the difficulty which the northern and other races experienced in enunciating the names of the places of which they made themselves masters.

In *Aosta, Saragossa, Grenoble,* we hear some barbaric chieftain endeavouring to articulate *Augusta, Cæsar Augusta, Grantianopolis.* In *Watling Way* we have an Angle or Saxon trying to say *Vitelliana Via.**

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tione Græcæ potissimum Linguæ," which drew forth a prohibition of the new practice from Gardiner, then Chancellor. "In sonis omnino ne philosophator, sed utitor præsentibus,"—the decree ran. "It were much better," the conservative Chancellor added, "that the Greek language itself with its sounds were wholly banished, than that the youth by his (Cheke's) teaching should imbibe rashness, arrogance, and vanity, most pernicious pests to all the rest of the life."

Caius also, the "Fui Caius" of Caius College, supported the old way in a treatise "De Pronunciatione Græcæ et Latinæ Linguæ cum Scriptione novâ." Erasmus himself had filled the Greek chair at Cambridge in 1510, where he lectured to small classes on the *Erotemata* of Chrysoloras. A well-known walk in the grounds of Queen's College retains his name. The question of pronunciation, after enlivening the learned world for a time, was at length decided practically. European scholars (the English included) adopted the new method. That is to say, in the several countries scholars took the liberty of reading the dead languages, as they did their own respectively. The result in England has been seen above.

* In some modern forms of ancient names we also probably hear conventional abbreviations similar to those which are so common in the British Islands, as Lemster for Leominster, Lanson for Launceston, &c., &c.

To the vocal organs of some of the early Norse immigrants in Italy *l*, in certain combinations, appears to have been a difficult letter: hence *Firenze* for *Florentia;* and generally *i* for *l* when followed by a vowel: as in the familiar *piano, piazza,* for *plano, plazza.* We may notice that some of our Indian tribes have the same difficulty in the utterance of English words: with Ojibways, *Montreal* is *Moneong, English, Yaganash,* and so on. It used to be considered amusing by Canadian boys that the Indian could not say "plenty;" it was always "pnenty."

R appears to have been occasionally another awkward letter. Hence we have for *Pistoria, Pistoia;* for *lavatorium, lavatoio;* for *cochleare, cucchiajo,* &c. Such a word as *bore* would inevitably have become *baw,* as an amusing periodical sometimes renders it. Some of our Indians again experienced the same difficulty with *r*. In Lewis's Iroquois Map, Toronto is set down as Deonda, Onyagara as Neageh, &c.*

The generality of the inhabitants of Saragossa and Grenoble would at this day as little recognize Cæsar Augusta and Grantianopolis, as the plain people of Brighton, Exeter, or Windsor would Brighthelmstone, Exanceaster, Wyndleshore.

Still these corrupted forms of ancient proper names, when placed side by side with their respective originals, have helped to preserve for us certain sounds and pronunciations, current long centuries ago, which would otherwise, perhaps, have vanished without a trace.

Sounds and pronunciations are, we know, very impalpable and fluctuating things; it is almost impossible to fix them—to embalm them, so to speak, from age to age—except by a musical notation.

In languages where rhyme has been admitted into poetical composition, a proof of ancient pronunciation may occasionally be discovered. Thus we learn from Spencer (1553—1598) that our curious modern pronunciation of "Tems," for Thames, is at least 300 years old. In his Prothalamion in honour of the Ladies Elizabeth and Katherine Somerset, "he walked forth," he says,

"Along the shore of silver-streaming Thames,
Whose rutty bank, the which his river hems
Was painted all with variable flowers,
And all the meads adorn'd with dainty gems
Fit to deck maidens' bowers."

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* In Baraga's "Otchipwe Dictionary" the articles *F*, *L*, and *R*, do not appear.

The wonder is that the name of the river has not come to be written, as so persistently pronounced. This is the kind of change which *has* taken place in the names which I am about to adduce. The traditional pronunciation was at length phonetically expressed and perpetuated.

Again, a pun or play upon words may sometimes determine the pronunciation of a name at a particular time; as in Warwick's

"Roam hither then!"

in reply to the Bishop of Winchester's reference to "Rome."—(1 Hen. IV. iii. 1.) This tends to shew that the pronunciation of *Room*—which was prevalent among old-fashioned orthoepists not many years ago—was not Shakspeare's rendering of "Rome." In *Roumelia,* however, and the *Roumans* of Moldavia and Wallachia, and in the Turkish sultanate of *Roum,* we have intimations that this was a pronunciation of Rome, at least in the Eastern Empire. Stocqueler (Oriental Interpreter, p. 198) gives *Room* as the Persian name to this day, of Constantinople, the *Nova Roma* of Constantine. In a somewhat similar manner, the familiar title "John of Gaunt" shews, by an incorrect anglicised form, how our forefathers designated the birth-place of that personage.*

But in the case of the ancient Greek and Roman proper names, to which I am about to refer, we are not guided to their pronunciation by the aid of rhyme—nor by a play upon words—although instances of this I think I have seen—but simply by the modern forms which they have assumed.

I begin with some proofs of an unexpected deviation from the usual European pronunciation of the first vowel.

1. The normal sound of the first vowel we may take to be *ah.*—We shall be pretty safe if we give it this sound in most of the foreign words we meet with. Its peculiarly English force is in many words, as we have seen, *ay,* which continentals would rather express by *e.* Still the curious thing is, that in some ancient proper names, as preserved in their modern form, the *a* seems to have had something of this anomalous English sound. Take the name for example, of a tributary of the Rhone, entering the main river, near Valence—the Isère: the letter which this accented *e* represents is *a* in the

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* Ghent: Fr. Gand. Shakspeare, of course, plays on "Gaunt,"—as, for example, in "Gaunt am I for the grave," (Ric. II. ii. 1); and Charles V. boasted that he could put all Paris into his "Gant" (glove), alluding to the great extent of the city (also *his* birth-place) in his day.

original word, *Isar* or *Isara* ; so that locally this *a* must have been sounded somewhat in our English way, or the name would not have been phonetically expressed and handed down in the modern dialect as *Isère*.

Again, take the familiar word *Clermont*, the name of the principal town in the Department of Puy de Dôme : the *e* also here represents *a* in the Latin word *clarus*—*Clarus Mons*. And similarly in *Clairvaux* in the Department of Aube=*Clarus vallis*,—although here the *ay* sound of *a* is represented by *ai*, as in *Aquitaine* also, from *Aquitania*, *Aix* from *Aquæ*, &c. In *Seine* from *Sequana*, the dipthong *ei* to some extent represents the same sound.

In the common words, *père*, *mère*, *frère* from *pater*, *mater*, *frater*, —*cher* from *carus*, *chair* from *caro*, *aimer* from *amare*, *taire* from *tacere*, *plaire* from *placere*, &c., there seem to be traces of the English long-sound of *a*. So also in *maire* from *major*—although there can be no doubt that in *Lago Maggiore*, we approach nearer the real vocable *major*. In the Italian word for an apple—*mela*—we are compelled to pronounce at least the stem of the Latin name for that fruit in the English manner—*mal-um* : this word ought to have been transmitted to us pure and simple, if *mah-la* was the sound that struck the ear of those who first wrote down the modern word.

One more instance will suffice to show that our English *a*-sound, however wrong it may be, has more to say for itself, than could have been conceived.

Take *Reate*—*Ree-ay-tee*, as the ordinary Englishman would call it ; a very ancient city in Central Italy. Its modern existing name is *Rieti*—*Ree-ay-tee*—proving that the *a* in this case had the English sound in the ear of the person who reduced the popular language to writing. Compare *Teate*, *hodie Chieti*.*

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* *Castra*, which in so many instances became *Caster* (comp. *Lancaster*), in more than one became *Caister*, (*e.g.* in Lincolnshire) in which we have phonetically the English sound of *a*. The Anglo-Saxon form of *caster* was *ceaster*, wherein *ea* was still pronounced *ay*. Where we have *chester* for *caster*, the *e* had probably the sound which we give it in Derby, Hertfordshire, &c. In other words the *ea* came at length to be written *a*, as in *shame* identical with *sceam* modesty. In the fact that *a* came to represent *ea*, we have probably the origin of the English sound of *a*.

The Anglo-Saxon *œ* also, was converted in some cases into *ea*, still sounded *ay*, as in *læfan* to leave. *Great* and *break*, with us, retain the sound of *ea* ; but to call *leave*, *lave* is not considered polished. *Shame-fast-ness*, from *sceam-fæst-nes*, has been changed to *shame-faced-ness* : "faced" is, of course, the phonetic blunder of some unweeting person, but it serves to shew that the *a* representing *æ* of *fæst*, (firm, resolute,) had the *ay* sound. In Wessex (Devon *e.g.*) the Anglo-Saxon rendering of *ea* survives : *heal* is popularly *hayle*, &c.—Query : Was *tea* intended to be the French *thé*, or the unusually elegant botanical *Thea* ? The Chinése word is said to be *tcha*. In Persian *cha-khutai* = tea of Cathay.

2. The true sound of *e* is *ay*, but that this was not its sound invariably, this word *Rieti* compared with *Reate*, shews twice over.—The same thing can be seen also in the numerous Italian words, in which *ri* represents the inseparable particle *re*, denoting repetition, &c. Take *rifacimento, i riformati*, for examples, and *di* for the familiar *de*. The same anomaly appears in *Avignon* on the Rhone. The ancient name of this celebrated city was the same to all intents and purposes—*Avenio*—where the *e* must have been pronounced like *i*, that is, like *ee*. Once more: compare *Monte Viso*, the point of junction of the Maritime and Cottian Alps. Its ancient name was *Mons Vesulus*, where the *e*, to have begotten the *i*, must have possessed the English sound. So in *Sena Gallica*, on the sea-coast of Umbria—the *e* is represented in the modern name *Sinigaglia* by *i*, that is *ee*.

Similarly the common Italian pronoun of the first person *Io, I*, is almost literally the Latin Ego, pronounced *Anglicè*. Also *mio*=*meus*, *Dio*=*Deus*, &c.

Let us turn also for a moment to the Greek ἦτα, the long *e*. In relation to it the anomalies are at first sight very extraordinary.—Most continentals call this vowel *ayta*; and so the recent Greek grammars instruct our youth to do. Still, take *Messina* for example, from which the strait between Sicily and the mainland has its name. The Attic form of the name is Μεσσήνη. The *i* in the modern name, pronounced of course *ee*, therefore shews, that one, at least, of the ancient pronunciations of η was just what we call it in English.—Similar examples are numerous: *Athens* itself—Ἀθῆναι—has for one of its modern popular appellations *Settines*—where *i*, that is, *ee*, does duty again for η. On the same principle the modern name of *Lemnos*, Λῆμνος, is *Stalimine*.* So *Macronisi*—literally Long Island—off the south east coast of Attica—gives again *i*, that is, *ee*—for the ἦτα of νῆσος island.†

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* As to the forms *Settines*, *Stalimine*, for *Athens*, *Lemnos*, it may not be uninteresting to explain, in passing, that the *s* prefixed seems to have arisen from ἐς a preposition of motion. Turks and others learning from native sailors the destination of their craft for such and such a place, erroneously mixed up the sound of the preposition with the local name, incorporating also in some instances, the definite article. Thus the island of *Cos* acquired the extraordinary name of *Stanco;* and Constantinople, in like manner, became *Stamboul*, or *Istamboul*—the *City*—literally "To the City." This syllable, *boul* reminds us of a pronunciation of *Sebastopol*, popularly prevalent during the Crimean war.

† The learned Theodore, Augustine's successor in A. D. 669, was a native Greek. This will help to account for the phenomenon noticed by Hallam on an examination of a certain MS. in the British Museum, of the Lord's Prayer in Greek, written in Anglo-Saxon characters.—"It proved," he says, "the pronunciation of Greek in the eighth century to have been mod-

This anomalous sound of ἦτα obtained also in the case of some common nouns.

The early French or Gaulish Christians who first heard the Greek word ἐκκλησία from the lips of their missionaries, caught the sound of the ἦτα as being that of our *i*, that is, as *ee*. Thus they wrote it down as *Eglise*. So we must suppose the traders of the Greek city of Marseilles to have sounded their *etas*, to account for *boutique* shop, being fashioned out of ἀποθήκη store. The same usage must have existed to some extent during the classic times, in Italy—if the Greek λῆρος nonsense, and the Latin *liræ*, pronounced *leeræ*, trifles, are identical.* Compare, finally, as a curiosity, *deer* with θῆρ.†

3. But it is time to turn to *i*. The European usage is to call this letter *ee*. Nevertheless it is clear that there was a sound attached to this vowel which approached the *ei*, or almost *oy*-sound, which the English people have chosen, in a multitude of cases, to give it.—*Loire*, for example, represents *Liger*—the ancient name of the largest river of France. With this compare *noir* from *niger; loisir* from *licet*, and *moi*, as derived from *mihi*. Also, it is well known that the Latin plural termination *i* is an equivalent for, if not identical with, the corresponding *oi* in Greek. In later Greek, long *i* was often exchanged for *ei* diphthong : not that this diphthong was pronounced like the English *i* ; but a deviation from the common *ee*-sound is certainly indicated.‡

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ern, or Romaic, and not what we hold to be ancient." *Vide* Hallam's *Literary History*, Vol. I., 92. The Greek of Christian missionaries in Britain, six centuries before Theodore, was probably similar. The sound which we give to the Greek *eta* may thus be a very ancient tradition.

* That in Quintilian's time (A. D. 90.) the principles of pronunciation were not the same in the Latin and Greek languages, is plain from what he says of the danger of a Roman child's acquiring faults of pronunciation from a use too long and too exclusive, of the Greek tongue. *Vide* Instit. Orat. Lib. I. iij. 3.

† Θῆρ is "wild animal"—and the cognate "deer," we know, is by no means exclusively the *genus Cervidæ* with which we in modern times associate the word. We shall recal Edgar's song in Lear (iij. 4,)

Mice and rats and such small deer
Have been Tom's food for seven long year."

It may be added as a brief corollary that *venison* is anything taken in hunting, and not exclusively the flesh of *Cervidæ*.

‡ The restoration of the *ei* diphthong to proper names which for a series of years have been printed with a simple *i*—although it may momentarily offend the eye—has the advantage of being a safeguard against false quantities. We may not quite like to see Phidias figuring as Pheidias—but not only do we thereby approach nearer to the actual name of the great sculptor, but the young competitor for classical honours is guarded against a possible heavy discount on his merit-marks. In like manner, although it may not be expedient to alter the

The present German mode of pronouncing *ei* does not appear to secure for us precisely the sound of ancient proper names. Cæsar and Tacitus expressed *Rhein* by *Rhen-us,* conveying to us a sound something like that which is to be heard in *Marseilles*. *Lingua Latina* in German, would be *Lateinische Sprache*: if *i* was pronounced *ee,* this *ei* of *Lateinische* doubtless once had more of this sound.

The rest of the vowels need not detain us long; as in regard to them the usage in ancient and modern times is nearly the same, and English custom is not much out of harmony with the continental.

4. *O* and *u,* we know, were not uncommonly interchanged in many words. In Greek we have *ὄνομα* Attic, and *ὄνυμα* Æolic, whence our second *y* in *synonymous:* in Latin *quojus, cujus,* &c. Hence in modern proper names we find the *o* often naturally representing one of the *u* sounds.

Fesole = Fæsulæ,
Genoa = Genua,
Modena = Mutina, &c.,
so popolo = populus, &c.;
and conversely, currant = Corinth.

And so *do-ge,* the title of the chief magistrate of *Genoa* and *Venice,* from *duc,* and *dogale,* ducal. We may compare with this, the short *u* sound which we in many English words give to *o:* e.g. London, Monmouth, Honiton, money. So "common" from "commun."—But in *Lucca,* pronounced *Lu-ca,* notwithstanding the two *c*'s, we have the long sound of *u*—the sound which is generally to be given to it in continental proper names. *Lucca* retains its ancient name in sound, as well as in form, with the exception of the double *c*.

5. *U* in modern proper names derived from the Latin and Greek, often represents, and no doubt retains the proper sound of *ou*. As in *Siracusa,* the ancient *Syracusæ* of the Romans, and the *Συρακουσαι* of the Greeks.* Compare the imaginary proper name *Utopia,* *Οὐτοπία,* rightly and in every respect denoting "Nowhere."

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popularized *Alexandria, Samaria, Attalia,* &c.,—yet in grave historical works, it is not amiss to give intimation of the *ei* diphthong which has been displaced by the penultimate vowel in them.

* It is a fixed rule that we are never to give to *u* in Italian words our favourite but anomalous English *ew* sound. The Duke of Newcastle, saluted "Dook" so often by our neighbours, in 1861, thus received in part what by his bearing and wisdom he merited in full, the title of the late rulers of Tuscany—*il granduca* (pron. *dooka*).

6. In regard, finally, to the vowel *y*, it would be difficult to say for what reason it was made to represent in Latin words the Greek *upsilon*, and why it should be called in French *e Grec*, did we not discover that in modern Greek this letter is pronounced *ee*. According to the Grammars for Romaic, ψύχη, strange to say, is *Pseechee;* and so to the Romans the word must have sounded when they wrote it down as *Psyche*.

But that the *upsilon* in very early times had not invariably this sound, may be gathered from *Saguntum*, which, though known to derive its name as well as its origin frow Ζάκυνθος, the modern Zante, was still by Roman historians written with the *u* unchanged. —One of the characteristic archaisms of Ennius was, to pronounce the *upsilon* as *u*. We feel as if the Roman Chaucer *ought* to call Pyrrhus, *Burrus :* Phryges, *Bruges*, &c., as we are told he did.

Again, that *y* does not well express the *u*-sound in Συρία is clear from the ancient as well as the modern name of Tyre, viz. *Tsour*, itself probably the stem of Συρία.—Cheke oddly gives *Surri* for Syria.—Similarly *Assouan*—a name familiar to voyagers on the Nile —also preserves the same sound of upsilon, *Assouan* being in Greek letters Συήνη, *i.e.* Syene, from which comes Syenite.

It was possibly the easy interchange of *y* with *u* that suggested to the old chroniclers, *Brute*, as the name of the eponymous hero of "Ynys Prytain,"[*] the island of Britain.

These mingled *u* and *e* (*i*) sounds of upsilon led at one time to perplexing anomalies and confusions in connexion with "satire" and "satirical." These words in French and Spanish, and in the English of the last century, exhibit a *y*. Two distinct things had come to be confounded—the Greek Σάτυροι, dramatic productions in which "satyrs" were actors;—and the Latin *saturae*—at a later period *satirae*—"dishes full of mixed fruits," literally,—and then, "free criticisms on things in general." From these latter compositions sprung "Satire"—with which the goat-footed monsters had nothing to do.

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[*] We cannot but be acquainted with several selections from the animal kingdom which are supposed to symbolize our race and nation; in regard to one of them, *Italus* = *Vitulus* (whence *veau* and *veal*) may help to keep us in countenance; but the generic term contained in the name mentioned above would seem, without explanation, to be carrying symbolism too far. "Brute" is here, however, a highly honourable human appellation. He was a Trojan Prince, a near relative of Æneas, the equally veritable founder of the Roman line of kings. Geoffrey of Monmouth (1152) goes very minutely into his history. In the "Tragedy of Locrine," attributed with some shew of reason to Shakspeare, this founder of the British line of kings is one of the *dramatis personæ*. Although supposed to be speaking before the time of the building of Rome, he is made, by a bold prolepsis, to say, when presenting a bride, Guendeline to Locrine, who is his son, that she is—

"A gift more rich than are the wealthy mines
Found in the bowels of *America*."

7. The continental pronunciation of the diphthong *ae* is *ay*. We have nevertheless *Gallicia* from *Galæcia, Isernia* from *Aesernia, Turbia* from *Tropæa, Vercelli* from *Vercellae. Velletri* from *Velitrae, Carsoli* from *Carsulae*, &c.; and in a sense different from Porson's

> "The Germans in 'Greek,'
> Are sadly to seek"—

for with the will and full power to call *ae, ay*—they in their own tongue turn *Græca Lingua* into *die Griechische sprache.*

8. *Oi* and *ou* have been virtually noticed.

9. Of *au*, the recent Greek grammars, compiled from German sources, give *ou* naturally, as the sound. This rendering in Greek words is probably right, Aristophanes giving us βαΰζειν, "to utter the sound βαῦ, βαῦ," *i.e.* to bark. The early Gauls, however, assigned to *ou* more of the *o*-power: thus they converted *Aurelianum* into *Orléans, Arausio* into *Orange*, and *aurum* into *or:* the latter word their cisalpine brethren made *oro*. Comparing *Claudius* with *Clodius, explaudo* with *explodo, caudex* with *codex*, &c., we see that a similar dialectic mutation was not uncommon at an earlier period. Our *suffocate*, from *sub* and *fauces*, exhibits the same change.—Wicklif and Cheke germanized in regard to *St. Paul*, the former calling him *Powl*, the latter *Poul*. To identify, as some do, the mythic Italian *Faun-us* with the Arcadian Πάν, we must suppose that in this instance at least, the *au* must have had something of the English sound, for *ā* = *au* nearly.

10. The diphthong *oe* remains. Of this combination, by which we know the Latins represented the Greek οι, and which we have reduced to *e* in "economy," the continental pronunciation is *ay*, or else the un-writable sound which we hear in "Goethe." Still I have one or two anomalies to offer: more doubtless could be found. Take the first syllable of the well-known proper name *Innsprück*, i.e. "Bridge over the Inn." This "Inn" is Latinized into *Œn-us*, where *oe* represents *i*, that is, *ee*. In a similar manner the modern *Vitulo* in the Morea is the ancient *Œtylus.*—In the French *ciel*, has descended to us a like pronunciation of *oe* in *coelum*.

These irregular jottings, casually made from time to time, have not I fear, presented anything that will be deemed of very great importance. Still, for us μέροπες ἄνθρωποι as we are, beings constituted to syllable their utterances, matters of the kind I have touched upon, however minute and trivial they may seem, must have a degree of interest. It is a collection, as it were, of verbal fossils that I offer—philologic "flies in amber," of considerable antiquity, yet modern in their aspect.

The vocal solecisms just enumerated, have been adopted by most of us as proprieties of speech. I might have urged them in the way of precedent to justify, to some extent, the traditional usages of our old-fashioned English grammarians; but I have adduced them not at all for this purpose, but simply as phenomena that require to be accounted for.

It would seem as if, at the period of transition from the old languages of Europe to the new, some one, on seeing the particular proper names and other words to which I have referred, had read them out in what we may call the English manner, giving to the vowels very nearly the sounds which we are accustomed to give them when we make use of our own language; and that then, a scribe or reporter, writing from ear, and accustomed to pronounce the vowels in the general European manner, had committed them to paper phonetically, producing thereby no longer the ancient classic names, but Italian, French, and Romaic appellations. How else came *Reate*, for example, to be handed down to posterity, in Italian, as *Rieti?*

All the subdivisions of the great families of language, we know, were themselves subdivided into dialects, originating in isolation of locality,—imitation of the individual peculiarities of chiefs, bards, &c., and other conceivable causes. When, then, new languages developed themselves from the intermixture of the Northerners and Southerners of ancient Europe,—an intermixture arising not only from conquest, but from joint service in Roman armies long before the fall of the Western Empire,—it is certain that dialects did not cease, but rather multiplied. Not one of the new tongues was uniformly spoken, any more than the old ones had been.

Now amongst the multitudes who, as adventurers or as soldiers, found themselves transplanted from trans-Rhenane or trans-Danubian regions, to sunny Provence, Lombardy, or Thessaly, we may be sure there were many of our ancestral blood-relations from the neighbourhood of the Elbe and the Weser. Did some of these, from genius of dialect previously spoken, or from structure of vocal organs and habits of speech combined, fall, when they began to articulate the euphonious vocables of the South, into some of the customs of pronunciation which distinguish ourselves, and so originate local dialects possessing, in respect of literal sounds, an affinity with the English tongue?

NOTE ON THE PRESERVATION OF SOME INFUSORIA WITH A VIEW TO THE DISPLAY OF THEIR CILIA.

BY JAMES BOVELL, M.D., TRIN. COLL., TORONTO.

In No. XXII. of the *Microscopical Journal* for 1858, Dr. Ralph writes: "Some months ago, I have made a decided advance in the preparation of insect tissues. I adopt the following plan: Place the insect alive in sweet spirits of nitre; it will die rapidly, and the air will be freely expelled, partly by reason of the volatility of the medium, and those with a proboscis, &c., will protrude it. After soaking a day, the specimens are to be rapidly transferred to a small quantity of clean spirits of turpentine, when all the sweet spirits of nitre will be expelled in the form of globules charged with grease; immerse in a further supply of turpentine in a clean bottle, and when the specimen has been a day or two (perhaps a little longer time may be required) it can be mounted in the chloro-balsam. Refractory specimens, or those which are very oily, may, after immersion in sweet spirits of nitre, and cleaning in turpentine, be again soaked in sweet spirits of nitre, when the turpentine will be expelled. If they are then a second time taken out of the sweet spirits and plunged in turpentine, the clearness of the globules which escape will indicate if the specimens are sufficiently cleansed. The sweet spirits of nitre must be fully expelled or the Canada balsam will assuredly quarrel with it, and form a cloud around the object. A modification of the above plan is, sulphuric ether in three times its bulk of spirits of wine."

Finding Mr. Ralph's method a very efficient one for insects, I thought that a similar effect would be produced on the ciliated Infusoria by the sweet spirits of nitre. Accordingly I procured from the ponds at the mouth of the Humber, west of Toronto, some slips of Anacharis and of Chara. On a portion of the latter, I was fortunate enough to discover a few active and finely developed Megalotrocha albo flavicans, and four of Floscularia ornata—these latter, June 27, 1863. Placing a couple of the Megalotrocha which were on the end of the Chara stem on a glass slide, with a drop of clear water, by means of a camel's hair pencil sweet spirits of nitre was added. At first it seemed to cause the active little creature to shrink, but in a moment or two it threw out its prettily arched oral extremity and displayed its ciliated fringed lappets. A little camphorated water with creosote, and which had been filtered through chalk, was allowed to insinuate itself under the glass cover, and the specimen sealed with black varnish. It is still in good preservation, being put up now for some time. Floscularia was not preserved as a permanent specimen.

I beg also to add a list of animalculæ which I have as yet found at the Humber, and in the Island ponds, Toronto.

Amœba princeps, in same place with small green sponges.
Micrasterias Boryana.
Enastrum rota.
Desmidium hexaceros.
Staurastrum paradoxum.
Stentor caeruleus.
Vorticella convallaria.
Leucophrys patula.
Kolpoda cucullus.
Paramecium aurelia.
Megalotrocha albo flavicans.
Floscularia ornata.
Oxytricha gibba.
Chilodon cucullus.
Rotifer vulgaris.
Staurastrum alternans.
Fragillaria capucina.
Gomphonema truncatum.
Cocconema lanceolatum.

The above list has been determined from Pritchard's work, and I hope will be found correct.

A PROPOSED CLASSIFICATION OF THE GENUS HELIX.

BY A. E. WILLIAMSON.

Among the mollusca there are many genera containing a large number of species. Of the fresh water varieties, the genus Unio has over 300 representatives; the genus Melania from 200 to 250; and the genus Lymnœa, although not nearly so numerous as either of the preceding, is still a very important division. Of the land shells the genus Helix bears off the palm in point of numbers, having upwards of 1500 species; the genera Bulimus, Pupa, and a few others also, present many varieties.

It will be seen by these facts that considerable difficulty may be encountered in arriving at the name of any species, even though we be well supplied with works of reference; for the labour of wading through a number of descriptions is not a very pleasing task, and it is only by figures of the shells, by well filled museums, by notes published in scientific journals, or by long practice and study, that we can get over this difficulty.

How much easier it would be, and, at the same time, prevent us from becoming disheartened at the long list of descriptions we may have to read over before finding the name of any shell, if some good classification could be adopted under which the shells might be grouped. This, I think, would in a great measure obviate the difficulties mentioned above. In following out this idea I have attempted the following classification of the genus Helix:—

DIVISION I.

SHELLS TOOTHLESS.

Section A.—Umbilicus closed or wanting.

Sub-Sec. A.—Shells large, over ½ inch in diameter.

1. *Lip reflected.*

H. albolabris (Say).—Whorls about 5½, with rather obtuse wrinkles, crossed by very minute lines, more obvious on the body whorl than on the spire; shell pale reddish brown; labrum (outer lip) widely reflected, flat, and white; breadth 1 inch. Canada.

H. hortensis (Müller).—A variety of *H. nemoralis*. Whorls about 5, rounded, wrinkled; shell thin and light; white, yellow, with or without clear brown bands; spire very much elevated; labrum very slightly reflected, except at base, where it is widely reflected; this pretty banded shell is an imported English species. It is found below Quebec.

2. *Lip simple.*

Sub-Sec. B.—Shells small, less than $\frac{1}{2}$ inch in diameter.

1. *Lip reflected.*

2. *Lip simple.*

H. chersina (Say).—Whorls about 6, wrinkles not distinct; shell sub-globose, conic; pale yellowish white, pellucid; body whorl slightly carinated above the middle; breadth about $\frac{1}{10}$ inch. Lower Canada.

H. egena (Say).—Whorls 5, not distinctly wrinkled, rounded; shell polished, aperture rather narrow, transverse; labrum at its inferior (lower) extremity, terminating at the centre of the base of the shell; umbilical region deeply indented; breadth over $\frac{1}{10}$ inch; it is broader than *chersina*, and much more elevated, and not so broad as *arborea;* the aperture is also of a different shape. Lower Canada.

Section B.—Shells umbilicated.

Sub-Sec. A.—Shells large, umbilicus exhibiting all the whorls.

1. *Lip reflected.*

H. concava (Say).—Whorls 5, irregularly wrinkled across; shell horn color or whitish, depressed; aperture large and short; labrum towards the base very slightly and inconspicuously reflected; greatest width $\frac{1}{10}$ inch. Canada.

2. *Lip simple.*

H. alternata (Say).—Whorls 5, striated across, with raised equidistant acute lines, forming grooves between them; shell reddish brown, varied or alternating with pale rays; aperture thin and brittle; breadth $\frac{3}{4}$ inch. Canada.

Mr. Tytler, B.A., has a specimen of this shell in his possession, found at Weston, the dark rays of which are a deep black.

H. perspectiva (Say).—Specimens from the States are nearly $\frac{3}{4}$ inch in diameter. Our Canadian species do not appear to be quite $\frac{1}{2}$ inch in diameter—*see Sub-Sec. B.*

Sub-Sec. B.—Shells small, umbilicus exhibiting all the whorls.

1. *Lip reflected.*

H. minuta (Say).—Ohio, &c.

2. *Lip simple.*

H. PERSPECTIVA (Say).—Whorls about 6, striated across, with raised parallel acute lines, forming strongly impressed sulcæ (furrows) between them; shell brownish; umbilicus very large. Paris, Upper Canada.

H. STRIATELLA (Anthony).—Whorls over 4, rounded, regularly striated with rather strongly raised lines; shell light yellowish brown; aperture thin and brittle; resembles *perspectiva,* but is much smaller, has fewer whorls, is lighter in color, and the umbilicus does not exhibit the whorls as plainly as in that species. Canada.

SUB-SEC. C.—Shells large, umbilicus not exhibiting all the whorls.

1. *Lip reflected.*

H. CLAUSA (Say).—Illinois and Pennsylvania.

2. *Lip simple.*

H. INORNATA (Say).—Pennsylvania.

SUB-SEC. D.—Shell small, umbilicus not exhibiting all the whorls.

1. *Lip reflected.*

H. PULCHELLA (Müller).—Whorls about 4, rounded, striated; aperture circular; labrum reflected, flat, and white; umbilicus round, large, and profound; breadth about $\frac{1}{8}$ inch. Canada.

The small size and reflected lip will readily distinguish this shell from all other species found in Canada.

2. *Lip simple.*

H. PORCINA (Say).—Whorls over 4, depressed above, rounded beneath; shell depressed, yellowish brown; epidermis rugose (   ) with minute very numerous bristles; umbilicus rather small, profound; breadth over $\frac{3}{10}$ inch. *H. hirsuta* (Binney) is identical with this species (Bland). Garafraxa, County of Wellington, U. C.

H. LIGERA (Say).—Whorls over 6, all except apical one, wrinkled across; shell pale yellowish horn color, polished, body whorl pellucid, yellowish white, opaque beneath the aperture; spire but little raised; umbilicus very small; breadth about $\frac{3}{10}$ inch. Toronto.

H. ARBOREA (Say).—Whorls 4, irregularly wrinkled across; shell very thin, fragile, horn color, pellucid; lip thin, brittle; umbilicus large and deep; breadth $\frac{1}{5}$ inch. Canada.

H. HARPA (Say).—Whorls 4, with numerous raised, equal, acute lines across, the spaces between them flat and wrinkled; shell conic, reddish brown; aperture truncated by the penultimate whorl (the whorl preceding the body whorl); spire very much elevated; umbilicus small, nearly concealed; length $\frac{1}{10}$ inch. Lower Canada. In shape somewhat resembles a *Bulimus* for which it might be mistaken.

H. HYDROPHILA (Ingalls).—Whorls about 5, rounded, striated across with very fine lines; shell thin, horn color or whitish and translucent, polished; umbilicus rather large, profound; breadth, $\frac{1}{5}$ inch. Upper Canada. This species and *Striatella* and *Alternata* are very common.

DIVISION II.

SHELLS TOOTHED.

SECTION A.—Umbilicus closed or wanting.

SUB-SEC. A.—Shells large, over $\frac{1}{2}$ inch in diameter.

1. *Lip reflected.*

H. ALBOLABRIS (Say).—Occasionally found with a small tooth. *See Division I., Sec. A., Sub-Sec. A.*

H. PALLIATA (Say).—Whorls 5; shell depressed with elevated lines, forming grooves between them; epidermis fuscous, rugose, with numerous tuberculous prominences; labrum widely reflected, white, a prominent tooth on the inner side above the middle, and a projecting angle near the middle of the lip; labrum (inner or pillar lip) with a large prominent white tooth; greatest breadth $\frac{4}{5}$ inch. It much resembles *tridentata,* but is larger and has no umbilicus. Some varieties have an acute carina, and are destitute of the minute prominences; breadth nearly 1 inch. Douglas Village, Garafraxa, Co. Wellington.

2. *Lip simple.*

SUB-SEC. B.—Shells small, less than $\frac{1}{2}$ inch in diameter.

1. *Lip reflected.*

H. INFLECTA (Say).—Lower Missouri.

2. *Lip simple.*

H. GULARIS (Say).—Ohio and Pennsylvania.

SECTION B.—Shells umbilicated.

SUB-SEC. A.—Shells large, umbilicus exhibiting all the whorls.

1. *Lip reflected.*

H. DIODONTA (Say).—New York.

2. *Lip simple.*

SUB-SEC. B.—Shells small, umbilicus exhibiting all the whorls.

1. *Lip reflected.*

H. FALLAX (Say).

2. *Lip simple.*

H. LINEATA (Say).—Whorls about 4, with numerous regular revolving lines; shell much depressed, somewhat discoidal; aperture longer than wide; umbilicus very large. As the shell is somewhat translucent, two pairs of white teeth, remote from each other, may be observed through the body whorl. One pair of these teeth is placed in the throat, and can be readily seen by looking in at the aperture; these teeth are nearly equidistant from each other, and from the extremities of the labrum. The other pair is placed too far in to be seen from the aperture; diameter $\frac{3}{20}$ inch. Lower Canada.

SUB-SEC. C.—Shells large, umbilicus not exhibiting all the whorls.

1. *Lip reflected.*

H. THYROIDUS (Say).—Whorls 5, wrinkled; shell rather thin, pale reddish brown; labrum widely reflected, white; labium with an oblique white tooth, not very prominent; umbilicus narrow, distinct; breadth $\frac{4}{5}$ to $\frac{9}{10}$ inch. Resembles *Albolabris* but is always umbilicated, smaller and toothed. Garafraxa, and Walkerton, Co. Bruce.

H. TRIDENTATA (Say).—Whorls 5, crossed by numerous lines, separated by regular grooves; shell depressed, brownish or horn color; teeth placed triangularly, one on the labium; labrum widely reflected, white, furnished with two teeth; umbilicus moderate; breadth $\frac{1}{2}$ inch. Canada.

2. *Lip simple.*

SUB-SEC. D.—Shells small, umbilicus not exhibiting all the whorls.

1. *Lip reflected.*

H. TRIDENTATA (Say).—About $\frac{1}{2}$ inch in breadth. *See Sub-Sec. C. above.*

H. LABYRINTHICA (Say).—Whorls 5 or 6, with conspicuous elevated lines across, forming grooves between them; shell dark reddish brown, body whorl lighter; labrum rounded; labium with a large lamelliform elongated tooth which appears to revolve within the shell, a smaller raised line revolves nearer the base but becomes obsolete before it arrives at the labium; umbilicus rather large; breadth $\frac{1}{10}$ inch. Lower Canada.

H. MONODON (Rackett).—Whorls 5 or 6, diminishing very gradually in breadth from the outer whorl to apex, marked with fine lines of growth; epidermis russet or chestnut color, with very minute hair-like projections; aperture contracted by a deep groove behind the lip;

labrum white, narrow, extending to the base of the umbilicus, and slightly contracting it; labium with a compressed white tooth; umbilical region deeply indented; greatest breadth ½ inch. Canada.

The hair-like projections, Dr. Gould says, are often wanting at every stage of growth.*

Some objections may be raised against a classification of this kind, such as the finding at times of shells normally without teeth with teeth; but these are exceptions and by no means common. *H. albolabris* has been frequently found in the United States with a small tooth. I have examined a great many Canadian specimens and as yet have not found one with this peculiarity. This difficulty is, however, easily obviated by placing such shells in each division under their proper sections—the description of course being attached to the section it normally belongs to.

Again, some shells are found occasionally with the umbilicus nearly or entirely covered, as in *H. fraterna* (Say); this peculiarity is very rare. I only know of it occurring in *fraterna*. It can be got over in the same manner as pointed out above.

As regards dividing the shells into large and small, I have taken ½ inch as the division line. This division is not a very good one on account of the variation in size of many shells, but it in some measure helps the object in view, as it places fewer specimens under each head.

I do not pretend to say that this classification is a perfect one; if it assists in the more ready determination of species it has amply fulfilled my object. It is more a classification of convenience than a strictly scientific one. Those who have made a study of Conchology will see its imperfections, but I hope at the same time they will turn their attention to perfecting some good classifications of not only the genus Helix, but of the other large genera.

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* None of the above descriptions are as full as the originals. I have given what I think to be the most important parts, sufficient to distinguish the shells one from another.

I have made brief descriptions of *hortensis*, *striatella*, *pulchella*, and *hydrophila*, from specimens in my possession, not having seen any descriptions of them.

A few more species besides those described in this paper are found in Lower Canada, viz., *H. Sayii* (Binney), *H. astericus* (Morse), and *H. exoleta* (Binney).

SYNOPSIS OF CANADIAN ARCTIADAE, INCLUDING SOME ADDITIONAL SPECIES LIKELY TO OCCUR IN CANADA.

BY WILLIAM SAUNDERS,
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Read before the Entomological Society of Canada, April 16th, 1863.

In pursuance of the plan first adopted by Prof. Hincks, of collecting and publishing in the "Journal" materials for a complete synopsis of our Canadian Entomological fauna, the following paper has been prepared; with the hope that it may be of some assistance to collectors, by enabling them more readily to determine their specimens, and also do something towards clearing up some hitherto doubtful points in connection with the specific characters of several species belonging to this beautiful and interesting family of Moths. The method of taking up, from time to time, certain families or sub-families of insects, and publishing descriptive lists of all the known Canadian species, including those likely to occur in Canada, is, we believe, a good one, and we feel sure that if continued it will greatly stimulate the growth of our favourite branch of science. We trust that those who have time and opportunity will assist us in the work, for the field is a wide one, and there is ample room for all to labour profitably.

In the preparation of this paper, free use has been made of the material collected by Dr. Morris, in the late Smithsonian "Synopsis of North American Lepidoptera," and also of that contained in Dr. Clemens' "Contributions to American Lepidopterology," published in the Proc. Acad. Nat. Sciences. We would also acknowledge our indebtedness to the many kind friends who have freely placed their specimens at our disposal. The collection thus gathered from various parts of the Province, has materially aided in making the list of Canadian species much more complete than it otherwise could have been, and also acquainted us with many interesting variations.

Fam. Arctiadae.—Herr-Schaef. Chelonides Boisd.

Stature usually robust. Maxillæ short, sometimes obsolete. Antennæ pectinate in the male, sometimes filiform. Palpi small pilose.

Thorax and abdomen, most often spotted. Wings entire deflexed. Frenulum conspicuous. Larvæ hairy.

The family may be thus tabulated:

AA. Antennæ of male pectinated.
  B. Fore wings streaked and spotted .. ...*Arctia.*
  BB. " " white or fulvous, with black spots. Sometimes wanting .... *Spilosoma.* *Hypantria.*
  BBB. " " bluish grey.......................*Euchœtes.*
  BBBB. " " pale yellow or ochre, banded or spotted with a lighter colour ...... *Halesidota.*
  BBBBB. " " white, with many blackish ringlets .... *Ecpantheria.*

AA. Antennæ of male filiform.
  C. Fore wings semi-transparent ....*Phragmatobia.*
  CC. " " densely clothed with scales.
    D. Hind wings red, with a black border ...*Deiopia.*
    DD. " " white or yellow, without spots, or sometimes with one or two small spots near the anal angle..................... *Hypercompa.*

Arctia Schr.

Head and thorax with long hairs. Palpi porrect, short, very hairy. Ocelli conspicuous. Thorax not crested. Wings gaily coloured and spotted. Abdomen stout, maculate. Hind tibiæ with four spurs; fore tibiæ simple. Flight nocturnal. Larvæ solitary.

Table of species:

A. Fore wings spotted, not striped.
  B. Fore wings brown.
    C. Hind wings with blue-black spots. Abdomen spotted with black .. .. *Americana.*
    CC. " " black banded. Abdomen with disk black *parthenos.*
  BB. Fore wings black, or blackish, with few spots *placentia.*

AA. Fore wings striped.

D. Fore wings with many stripes.

E. Central stripe wide.

F. Hind wings red, anterior margin bordered with black } *parthenice.*

FF. " " red, anterior margin with black spots ... } *virgo.*

FFF. Hind wings flesh-colour, or slightly tinged with red ...... } *dione.*

FFFF. " " ochre-yellow or brownish; external edges with a double black border .... } *nais.*

EE. Central stripe narrow .... *virguncula.*

DD. Fore wings with few stripes.

G. Hind wings ochre-yellow, with black spots...... } *phalerata.*

GG. " " reddish, with black spots .... } *philyra.*

GGG. " " bright red, with a broad black border .... } *decorata.*

GGGG. " " lightish brown, with yellow spots } *celia.*

(NOTE.—All known Canadian species will be followed by a note of exclamation (!). The others are natives of the adjoining States, and will probably also be found to occur with us.)

A. Americana !—Harris. Figured in "Agassiz's Lake Superior," Fig. 7.

Palpi dark brown above, red beneath. Head brown. Antennæ yellowish-white above, with brown pectinations. Thorax brown, bordered in front with a white band which extends on each side to the extremity of the shoulder covers. Collar bordered above and below with red, with a front line of the same colour

Primaries brown, deeper in colour towards base, with several white spots on costa, and crossed by broad irregular anastomosing lines of the same colour.

Secondaries bright ochre-yellow, with from four to six blue-black spots, three larger than the others.

Abdomen ochre-yellow, with a reddish tinge, and a dorsal row of large black spots. Legs dusky; thighs and anterior tibiæ fringed with red.

Length of body 9-10 lines. Wings expand 25-28 lines.

The larva of this species does not complete its growth in the autumn, but attains only to about three-eighths of an inch in length, when it hybernates, seeking shelter in some crevice, usually under the loose bark of decaying trees. At this period it presents the following appearance:—Head black; body dark brown, with transverse rows of tubercles, from which spring dense tufts of intermingled black and white hairs. For two summers past we have reared the larva from eggs deposited by captured females, to the period of hybernation; but have failed to preserve them alive during the winter. Several years since we found, in the latter part of May, a full-grown specimen, but it entered the chrysalis state before an opportunity occurred for describing it.† They are somewhat omnivorous in their appetites, but show a preference for the common garden lettuce and lamb's quarter (*Chenopodium album.*)

The perfect insect usually appears in the latter part of June or early in July.

Hab.—London, not common; Toronto (Mr. Bethune); Kingston (Mr. Rogers); Trenton Falls, N.Y.; Lake Superior.

**A. parthenos !*—Harris. Figured in "Agassiz Lake Superior," pl. 7. Var.: *A. Americana.*—Walker.

"Head brown, with a crimson fringe above, and between the black antennæ. Thorax brown above, with an arcuated cream-coloured band, which is continued on each side of the outer edge of the shoulder covers; upper edge of the collar crimson-red.

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† Since the above was written, specimens of the full grown larva have again been procured. They were found on the 18th of June, under some logs. The following description will serve to complete the history of this species:—Length two inches. Head black and bilobed. Body deep velvety-black, with transverse rows of tubercles, most of which are of a whitish colour, emitting tufts of hair. Hairs on second, third, and fourth segments dull red—on the latter slightly intermixed with white; those along the back are very long and silky, white mixed with black; while those on the sides are shorter, and of a dull red color. Under surface dull black, with a thickly set row of tubercles, in continuation of those above, on the third, sixth, eleventh, and twelfth segments, from which spring tufts of very short stiffish red hairs. Feet and prolegs black and shining.

* Those species prefixed with an asterisk (*) are not in the writer's collection; he would therefore feel greatly obliged for specimens from any person possessing duplicates of such.

Primaries dark brown, with three small cream-coloured spots on the outer edge; four spots of the same colour in a line near the inner margin, and several more scattered on the disk.

Secondaries deep ochre-yellow; with the base, the basal edge of the inner margin, a triangular spot in the middle, adjoining the basal spot, *and a broad indented band behind*, black.

Abdomen dusky above, tawny at the tip, and beneath. Legs dusky; thighs and tibiæ fringed with crimson hairs."

Larva undescribed.

Hab.—Valley of the River Rouge (Mr. D'Urban); Lake Superior; Mass.

**A. placentia*.—Abbot. Figured in Sm. Ab. pl. 65.

"Fuscous; primaries with one or three pale testaceous spots; secondaries reddish, margin and some sub-marginal spots fuscous. Abdomen above reddish, with the dorsal spots and apex fuscous.

Var. a.—Fore wings with the outer fringe partly pale testaceous; and with several spots and dots of the same colour in the disk.

Var. b.—Fore wings with the outer fringe wholly blackish-brown, unspotted, except two very minute testaceous dots."

Larva undescribed.

Hab.—North America.

A. parthenice !—Kirby. Var. ?—*A. virgo.*

Palpi black, tipped with whitish. Head buff in front, black at the sides. Antennæ dark brown. Thorax flesh-coloured, with two small anterior and three large posterior black stripes.

Primaries black, margined and striped with buff; veins and their branches narrowly striped; a wide central stripe extending to the hind margin, furcate just beyond the base; with the lower branch again furcate near the posterior angle. The central stripe is joined at an acute angle at the tip by a branch extending to the costa; another stripe from the costa, about the apical third of the wing, extends to the median stripe, below which it is furcate,—one part terminating beyond the middle, the other at the end of the lower stripe.

Secondaries bright red, with five or six irregular black spots edged with yellow, *mostly towards the posterior margin. A large patch of black at the apex, which is prolonged along the anterior margin, bordering it to the base.* Ciliæ yellowish.

Under surface paler than the upper, with the markings less distinct; margins yellow.

Abdomen red above, whitish at the tip, with a black dorsal macular band; black below, with a central row of four or five white spots. Legs black, fringed along the thighs and at base with brown; posterior edge of hind tibiæ whitish.

Length of body 8½ lines. Wings expand 25 lines.

Larva.—Length one and three quarters to two inches. Head black, with a light spot on each side. Body black, with a dorsal flesh-colored stripe. A transverse row of prominent tubercles on each segment, of a yellowish flesh-color, from which arise tufts of stiff hairs, which are black on the back and brown on the sides of tke body. Feet and prolegs yellowish, tipped with black.

This larva, like that of *Americana,* hybernates when partly grown, and completes its growth the following spring. It feeds readily on lamb's quarter (*Chenopodium album*) or on grass.

Hab.—London. Not uncommon. Montreal (Mr. D'Urban.)

A. parthenice closely resembles the following species "*virgo,*" and has usually been regarded as a mere variety of it; but since the larva described above, of which I have reared several specimens, does not agree with that of "*virgo*" as described by Harris, it is probable that they are distinct.

A. virgo !—Hubner.

Palpi black. Head buff in front; black at the sides. Antennæ ferruginous. Thorax buff or flesh-color, with five black spots; two small ones in front and three larger on disk.

Primaries black, margined and striped with buff, flesh-color, or sometimes reddish. Veins and their branches striped; two wide longitudinal stripes joined near the base, and extending to the hind margin; the lower one furcate near the end; three transverse from costa; the two outermost extending to the hind margin, the inner one to the median stripe or just below it. A short transverse stripe unites the upper with the lower longitudinal ones beyond the middle of the wing.

Secondaries deep red, sometimes with a pinkish tinge, with from seven to nine irregular black spots edged slightly with yellowish, not collected towards the posterior margin, but scattered uniformly over the surface of the wing. Cilia yellowish-red.

Under surface paler in color, with the same markings.

Abdomen of the same color as secondaries, with a macular black band, or sometimes a row of black spots, along the back. Under surface black, or very dark brown, with sometimes two or three faint whitish spots along the centre. Posterior edge of hind tibiæ buff.

The perfect insect appears about the end of July.

Length of body 8–9 lines. Wings expand 21–27 lines.

" Larva brown, rather thickly covered with tufts of brown hair."

Var.—Primaries with all the stripes wider, occupying the greater portion of the surface of the wing.

Hab.—London. Not uncommon. Cobourg (Mr Bethune.). St. Catherines (Mr. Beadle). Hamilton (Mr. Reynolds). Toronto (Prof. Croft; Dr. Morris). Kingston (Mr. Rogers). Montreal Mr. D'Urban). Nova Scotia; New York; Illinois.

A. dione!—Hubn. *Argæ.*—Drury. Figured in Drury i. pl. 18; Sm. Ab. pl. 63; Naturalist's Library, vol. xxxvi. pl. 19.

Palpi black above, reddish below. Antennæ whitish above, under surface brown, extremities nearly black. Head and thorax pale buff, with a pinkish tinge, especially towards the front; thorax with five black spots, two small ones in front and three larger on disk, one central and one on each tegulæ.

Primaries black, widely margined and striped with pale buff or cream-color, sometimes with a pinkish tinge. Stripes all wide (especially the central one and its lower branch), occupying the largest portion of the surface of the wing.

Secondaries reddish flesh-color, with a fulvous marginal line behind, and eight or nine black spots, chiefly along the hind margin.

Under surface with similar markings, the black spots less distinct, and costal edge of primaries yellowish-red.

Abdomen reddish above, pale below, with five rows of black spots, one dorsal two lateral, and two on the underside; the latter, largest. Under surface of thorax, reddish, with two black spots below the eyes. Legs whitish, edged with brownish-black; anterior and middle thighs bordered in front with red.

Length of body 7 lines. Wings expand 18 lines.

The perfect insect may be taken from early in June to the end of July.

The description given of the larva in the "Smithsonian Synopsis" does not exactly agree with that given by Harris, which is as follows: "Length one inch and a half. Color dark greenish-grey; appearing almost black from the black spots with which they are thickly covered. There are three longitudinal stripes of flesh-white on the back, and a row of kidney-shaped spots of the same color on each side of the body. The tubercles are dark grey, each producing a thin cluster of spreading blackish hairs. It attains its full growth in the month of October."

Food plants.—"Plantain and other herbaceous plants. Abbot states that they sometimes make great devastation among young Indian corn in the Southern States."

"Var. a.—Primaries reddish-white, with cuneiform black spots. Secondaries red, with black-yellow bordered spots.

Var. b.—Spots of the primaries much larger, and forming a stripe towards the hind border.

Var. c.—Spots of the primaries still larger, and more inclined to form stripes. Spots of the secondaries without yellow borders."

Var. d.—Secondaries whitish, spots small and without yellow borders.

Hab.—Niagara (Dr. Morris). Toronto (Prof. Croft). Mass.; New York; Illinois; Georgia.

A. nais!—Drury. Figured in Drury, pl. 7.

Palpi black. Antennæ black above, lighter beneath. Head and thorax dull buff, with a brownish tint; thorax with five black spots, two small ones in front and three larger on disk, one central and one on each shoulder cover.

Primaries black, with pale ochre stripes; margins, veins, and their branches narrowly striped; central longitudinal stripe wide, furcate not far from the base, sending a wide branch to the posterior angle, where *it* is also furcate near its termination; the central stripe is again furcate about the apical third of the wing, emitting a wide branch, which joins the lower one; a short wide stripe crosses the apex, extending from the extremity of the central one to just under the costal edge.

Secondaries ochre-yellow, with a brownish tinge; with one or two small black spots, and a broad irregular dusky black border along the external edges, widest at the apex and narrower towards the inner angle; a line of ochre-yellow extends half through the black border, about the middle of the wing, and the border has also one or two small, dull, ochre spots in it.

Under surface paler, with similar markings; veins on secondaries narrowly striped with pale buff while passing through the black border.

Abdomen deep ochre, whitish towards the tip, with a black dorsal band, and lateral rows of spots of the same hue; under serface, thorax dull brownish, abdomen black, annulated with whitish. Legs brownish black, femora edged externally with buff.

Length of body 7 lines. Wings expand 18 lines.

Larva undescribed.

Var. a.—*Male.* Fore stripe of the primaries not joining the costa.
Var. b.—*Male.* Inner border of the secondaries reddish.
Var. c.—*Male.* Primaries with no pale oblique band towards the tip.
Var. d.—*Female.* Like Var. c. Secondaries red, with broad blackish borders. Abdomen wholly brown, except on each side above towards the base.
Var. e.—*Female.* Primaries with testaceous veins; fore stripe and part of the middle stripe almost obsolete."

Hab.—Hamilton (Mr. Reynolds). Massachusetts.

A. virgincula!—Kirby. Figured in Faun. Bor Amer. iv. pl. 4.

Palpi small, brownish black Antennæ black, with a brownish tinge. Head flesh-colored above, black at sides. Thorax pinkish-buff, with five black spots, two small ones in front, and three larger on disk.

Primaries black, margined, and striped with pale flesh-color. Costal margin, veins, and their branches, narrowly striped. *The central longitudinal stripe along the median vein linear throughout.* A wide stripe, having its origin at the base immediately under the median vein, and deflected from thence to the hind margin, where it is furcate. A zig-zag subterminal band, beginning on the costa near the apex and terminating near the posterior angle, where it joins the end of the wide longitudinal stripe. Two wide stripes arise from the costal edge; the first, about the middle of the wing, extends to the median vein, or just below it; the second at the apical third, uniting with the wide longitudinal stripe below.

Secondaries pale reddish-buff, with five or six black spots, *one within, the others along the posterior margin, where they form an irregular macular band.* Ciliæ whitish.

Under surface paler, with markings less distinct, excepting towards the apex.

Abdomen reddish above with the tip, and a dorsal macular band black. Under surface dark brown, imperfectly annulated with whitish hairs.

Length of body 5-8 lines. Wings expand 17 to 20 lines.

Larva undescribed.*

Var. a.—Primaries with the stripes reddish; secondaries pinkish-red. Abdomen with two additional rows of spots at the sides; under surface black, centered with yellowish-brown.

Var. b.—Primaries with the stripes nearly white; secondaries pinkish-orange. Abdomen with two additional rows of spots; black, with some faint lightish central spots.

Var. c.—Primaries with the stripes pale; secondaries bright red. Abdomen entirely black below.

Var. d.—Primaries with all the stripes narrower and reddish; secondaries bright red. Abdomen with macular band above very wide; entirely black below.

Var. e.—Primaries with the stripes reddish-ochre, costa edged only to about the basal third of wing; secondaries vermillion-red. Abdomen deep black below.

Hab.—London: common. Toronto (Mr. Bethune; Prof. Croft; Dr. Morris). St Catharines (Mr. Beadle). Hamilton (Mr. Reynolds). New York.

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* A single specimen of the larva of this species was taken during the present season, *on* the 2nd of June, under a log. Length 1¼ to 1½ inches. Head *small,* black, reddish at sides. Body dull black, *rather glossy,* with a slightly reddish tinge. On each segment is a transverse row of black tubercles, emitting tufts of stiff bristly hairs *of the same hue.* Hairs on the two hinder segments longer than those on the other. A faint whitish dorsal line from the head to the third segment, and another faint mark of the same color on the terminal segment. Under surface dull red, feet and prolegs of the same color.

A phalerata !—Harris. Figured in Harris' Insects, new Edition, Fig 166.

Male. Palpi black. Antennæ black above with light-brown pectinations. Head ochre-yellow, narrowly bordered with black at the sides. Thorax ochre-yellow with THREE black stripes, one central, and one on each tegulæ.

Primaries black, with *very wide stripes of ochre yellow*, one along the costa to near the tip, another along the hind margin, and a third very wide central stripe, furcate about the middle, both branches extending to the hind margin ; the end of the lower branch is joined by a transverse stripe, which extends obliquely to the costa ; and from the termination of the upper branch arises another extending across the tip to near the costa.

Secondaries bright ochre-yellow, with three black spots along the posterior margin, and a patch of black at the anterior angle, which is prolonged along the anterior margin to near the base of the wing. Ciliæ buff.

Under surface with the same markings and nearly as distinct.

Abdomen ochre-yellow, with a wide dorsal black band narrower towards the thorax, below black, with a central yellow band, wider towards thorax. Legs black, fringed with brownish-yellow hairs at their base ; anterior thighs spotted with reddish-yellow.

Length of body 7 lines. Wings expand 16 lines.

Larva undescribed.

Var. Secondaries with a reddish tinge towards the inner margin. Under surface of abdomen black, with one small yellow dot near base.

Hab.—Cobourg. (Mr. Bethune.)

A philyra !—Drury.

Male. Palpi black. Antennæ blackish brown. Head and thorax reddish flesh color, the latter with two small black spots in front, three larger on disk, and a short one on each side at base of primaries of the same hue.

Primaries black, with pale flesh-colored stripes ; one along the costa deflected at the apical third of the wing to the posterior angle ; a broader stripe beneath the median vein, furcate about the middle, and extended to the hind margin, where it is turned at an acute angle towards the costa. The lower branch is also extended to the hind margin, where it is again slightly furcate, and joins the deflected portion of the costal stripe near the posterior angle. Inner margin bordered with the same color.

Secondaries reddish flesh color, deeper in color towards base, with three black spots along the hind margin, and a patch of the same color extending from the anterior angle along the front margin to near the base.

Under surface with the same markings, but paler.

Abdomen reddish, wlth a black dorsal band above; below brownish-black. Anterior thighs edged with buff.

Length of body 5½ lines. Wings expand thirteen lines.

Larva undescribed.

Hab.—St. Thomas, seventeen miles from London. Rare.

A decorata !—Saunders. Described in Proc. Ent. Soc. Philada.—Vol. 2. No. 1.

Female. Tongue bright yellow. Palpi black. Antennæ black, slightly pectinate. Head black, with a tuft of yellow hairs between the antennæ. Thorax ochre yellow, with two small linear spots in front, and three larger ones on disk, one central, and one on each shoulder cover, and a small spot of the same hue on each side at base of primaries.

Primaries deep velvety black, with rich ochre-yellow stripes, one on costa terminating at the apical third of the wing; one broad central stripe along the median vein to within a third of the hind margin, slightly enlarged at the tip, where it is joined at an acute angle by a smaller stripe which terminates just under the extremity of the costal band. This central stripe is notched or obscurely furcate about the middle; the lower part of the notch extends a very short distance towards the hind margin, terminating in a point, and in a line with this further towards the posterior angle, are one or two very minute yellow dots. Inner margin with a border of the same color, gradually widening towards the base.

Secondaries bright red, widely bordered with dull black, excepting on the inner margin; a small red dot set in the black border not far from the apex. Ciliæ vary in color from ochre-yellow to dark brown.

Under surface paler with the same markings.

Abdomen deep black, with a patch of ochre-yellow or orange on each side at base, wide where it joins the thorax and narrow at its termination on the third segment. A yellowish dot on each side of fourth and fifth segments, and one on centre of back near tip. Under surface entirely black.

Length of body 6 lines. Wings expand 16 lines.

Larva undescribed.

Hab.—St. Catherines. Rare. (Mr. Beadle.)

A celia !—Saunders. Described in Proc. Ent. Soc. Philadelphia, Vol. 2. No. 1.

Male. Palpi black above, yellowish beneath. Head yellow, with black lateral stripes. Antennæ brown, pectinated. Thorax yellowish-white, deeper in color towards the head, with two short black stripes in front, and three longer and larger on disk, one central and one on each tegulæ.

Primaries brownish-black, with white stripes, a wide stripe having its origin at the base of the median vein, and from thence deflected towards the posterior angle, where it grows narrowly linear, from this two branches proceed: the first from about the centre of the wing extends in a straight line to the costa, the second obliquely towards the apex, terminating under the costal edge; a subterminal zigzag line forming a distinct W, crossed at the top by the oblique band.—Costa edged with yellowish to about the apical third of the wing.

Secondaries lightish-brown, with two irregular yellow spots about the middle of the wing, and a stripe of the same color extending from the base along the submedian vein, to within a third of the hind margin. Inner margin yellow. Ciliæ brown, intermixed with white.

Abdomen yellow, with a dorsal macular band black, and a row of black spots on each side; under surface whitish, with imperfect black bands. Legs black, spotted with yellow, and with tufts of yellow hairs at their base.

Length of body 6 lines. Wings expand 14 lines.

Larva undescribed.

Var. a. *Male.* Secondaries dark-brown, with the yellow spots somewhat smaller, inner margin brown. Legs edged with yellowish-white.

Var. b. *Male.* Antennæ light-brown. Head and thorax with a pinkish tinge. Secondaries with the central spots smaller than the type, and of a reddish color. Abdomen yellowish-red, with the central portion of under surface greyish-white.

Hab.—Toronto. The type from Mr. Bethune, Vars. a and b from Professor Croft.

Spilosoma.—Stephens.

Palpi more or less exceeding the clypeus, hairy beneath, first and second joints usually short, sometimes the joints nearly equal.—Wings white or fulvous with black dots, sometimes wanting. Abdomen with five or six rows of black dots, sometimes indistinct; one above, one below, and two on each side. Hind tibiæ with two pairs of spurs near the tip, sometimes minute.

Table of species :

A. Wings white.
B. Wings with few dots .... *Virginica.*
BB. Wings with many dots .... *acrea.*
BBB. Wings without dots .... *collaris.*
AA. Wings fulvous.. *Isabella.*

S. Virginica !—Fabr.

Palpi black above, yellowish below. Antennæ white above, with black pectinations. Head and thorax white and very woolly.

Primaries white, with a black discal dot.

Secondaries white, with three black dots, one on disk, and the others towards the hind margin.

Under surface with the same markings; the dots on secondaries, especially the discal one, more distinct.

Abdomen deep yellow above, whitish beneath, with five rows of black spots, one dorsal, and two on each side. Anterior coxæ, and femora ochre-yellow, the latter with a black spot; tarsi annulated with black.

Length of body 6–7 lines. Wings expand 17–19 lines.

"The Larva varies much in color, often of a pale yellow or straw color, with a black line along each side of the body, and a transverse line of the same color between each of the segments, and it is covered with long pale yellow hairs. Others are of a brownish-yellow or foxy red. Head and ends of the feet ochre-yellow. Body below blackish." Will feed on almost any herbaceous plant.

Var. a. Wings wholly white.
Var. b. Wings wholly white above, below primaries with a small black dot above the disc; secondaries with three black dots.
Var. c. Primaries with one black dot, secondaries with two.

Var. d. Same as c, with an additional black spot on underside of primaries near base.

Var. e. Primaries with two black dots, secondaries with same number.

Var. f. Primaries with two black dots, secondaries with four black dots, primaries below with a dot at base.

Var. g. Primaries with three black dots, secondaries the same.

Var. h. Same as g, with the black basal dot on primaries below.

Var. i. Primaries wholly white, secondaries with three black dots.

Hab.—London, very common; Cobourg (Mr. Bethune); St. Catherines (Mr. Beadle); Hamilton (Mr. Reynolds); Toronto (Prof. Croft, Dr. Morris); Kingston (Mr. Rogers); Montreal (Mr. D'Urban.)

S. acrea !—Drury.

Female. Palpi black above, yellowish beneath. Antennæ black. Head and thorax white and woolly.

Primaries white, with many black dots, those along the costa largest.

Secondaries white, with from three to six black spots chiefly along the hind margin.

Wings below white, with fewer spots, veins tinged with yellowish.

Abdomen deep ochre-yellow above; apex and under surface white, with six rows of black spots, the dorsal row largest. Thighs and fore tibiæ ochre-yellow. Tarsi black, annulated with white.

In the *Male* the primaries are white, with a yellowish tinge; secondaries deep ochre-yellow; under surface of body and wings ochre-yellow.

Length of body 6–8 lines. Wings expand 18–23 lines.

"Larva white when young, nearly black when full grown; intermediate stage reddish brown; two yellow lines along the sides, and a transverse series of orange spots on each segment. From the back of each segment arises a tuft of blackish hairs." Feeds on almost every herbaceous plant.

Hab.—London, common; Cobourg (Mr. Bethune); Toronto (Dr. Morris, Prof. Croft); St. Catherines (Mr. Beadle); Hamilton (Mr. Reynolds); Kingston (Mr. Rogers); Montreal (Mr. D'Urban.)

S. collaris !—Fitch.

Palpi brownish-black above, yellow below. Antennæ whitish above, with brown pectinations. Head yellow. Thorax yellow in front, nearly white behind.

Primaries glossy white, semi-transparent; with the costal edge, sub-costal vein, and space between, yellow; paler towards apex.

Secondaries wholly white, semi-transparent.

Under surface same as upper, but paler, with the discal cell on primaries partly dusky.

Abdomen rather slender, whitish annulated with yellow, with a dorsal and double lateral rows of black dots. Anterior femora pale yellow; feet rather long and slender, brownish. Hind tibiæ with the two pairs of spurs long.

Length of body 5 lines. Wings expand 14 lines.

Larva undescribed.

Hab.—London, rare; Mississippi.

S. Isabella !—Abb. and Sm.

Palpi brown, short, and hairy. Antennæ filiform whitish above, brownish-yellow below. Thorax yellowish-brown, anterior portion darker.

Primaries fulvous or brownish-ochreous, sometimes tinged with red; with a discal spot, and an indistinct sub-terminal line of spots along the outer margin, black.

Secondaries yellowish-ochreous with a roseate tinge, semi-transparent; with two black discal spots, and several more of the same hue along the hinder margin.

Under surface of primaries rosy, margined with ochre-yellow, and with a short black stripe on sub-median vein near base; secondaries similar in color to the upper surface, with discal spots on both larger and deeper in color.

Abdomen ochre-yellow, with a reddish tinge, and three rows of black spots. Anterior thighs crimson in front; legs black.

Length of body 7–8 lines. Wings expand 14–16 lines.

Larva. Head black and shining; body brownish-black, with irregular transverse rows of tubercles, from which arise tufts of stiff hairs, which are dull yellowish-red along the middle of the body and black towards each end. Under side lighter in color than upper. This larva, which is one of our commonest species, completes its growth in the autumn, and hybernates through the winter. In spring they usually feed for a few days before going into chrysalis; they will eat almost any herbaceous plant. Length, about one and a half inches.

Var. a. Primaries deeper in color both above and below, crossed above by three wavy bands of dusky black; underside with an additional black line on disk.

Var. b. Primaries like the type; secondaries whitish-yellow.

Var. c. Markings on primaries very indistinct; secondaries immaculate.

The perfect moth appears from late in May to the middle of June.

Hab.—London, very common; Cobourg (Mr. Bethune); Toronto (Prof. Croft, Dr. Morris); St. Catherines (Mr. Beadle); Hamilton (Mr. Reynolds); Kingston (Mr. Rogers); Montreal (Mr. D'Urban.)

Hyphantria.—Harris.

Palpi hairy beneath, *scarcely extended beyond the clypeus.* Second joint very short, terminal joint nearly rudimental. Wings white, sometimes spotted with black. Abdomen with rows of black dots. Hind tibiæ with *one pair* of small apical spurs.

Table of species:

A. Wings white, without spots ....*textor.*
AA. Wings white spotted ....
    B. Primaries with many black spots..................*cunea.*
    BB. Primaries with one black dot ....*punctata.*

**H. textor.*—Harris.

"Palpi blackish. Antennæ blackish-brown.

"Wings pure white, without spots.

"Fore femurs tawny yellow, without spots.

"Larva greenish, dotted with black; a broad blackish stripe along the top of the back, and a bright yellow stripe on each side. The warts from which the thin bundles of hairs proceed, are black on the back, and rust yellow or orange on the sides. Head and feet black. They spin large webs, and live in communities."

Hab.—Mass.; Penn.; Georgia.

**H. cunea.*—Drury. Figured in Drury I, pl. 18; Sm. Abb., pl. 70.

"Antennæ blackish brown. Thorax ash color, usually unspotted, sometimes with a few black spots.

"Primaries white, with highly variable markings, usually with numerous black spots; external margin with five spots; those nearest the tip triangular; sometimes the spots fewer.

"Secondaries without spots, sometimes with a dark spot near the external edge, and faintly marked near the external angle.

"Abdomen white, with three rows of minute black spots, frequently inconspicuous. The fore coxæ and femora luteous; tarsi blackish.

"Length of body 5–6 lines. Wings expand 13–18 lines."

Larva undescribed.

Hab.—Mass.; Penn.; Georgia.

**H? (Spilosoma) punctata.*—Fitch. Fitch's Third Report, p. 265.

"Primaries white, with a black central dot, and in the males a row of small blackish spots, extending from the middle of the inner margin to the tip.

"Secondaries white.

"Thighs and hips yellow in front; a continuous black stripe on fore side of anterior feet and shanks."

Larva undescribed.

Hab.—New York.

Euchætes.—Harris.

Wings bluish-gray, without spots. Abdomen smooth, spotted. Hind tibiæ with two pairs of spurs.

**E. Egle.*—Drury. Figured in Drury II., pl. 20. Larva figured in Harris' Insects, new edition, fig. 172.

"Head gray; occiput with a narrow luteous line. Thorax gray.

"Wings rather long, thin, and delicate, of a bluish-gray color, paler on the front edge, and without spots.

"Abdomen above dark yellow, with a dorsal and lateral row of black spots; beneath whitish or gray. Fore coxæ woolly, and touched at the sides with luteous."

Wings expand 17–20 lines.

"Larva black, with a whitish line on each side, and thickly covered with short tufts of hairs, proceeding from little warts. Along the top of the back is a row of short black tufts, and on each side, from the fifth to the tenth ring inclusive, are alternate tufts of orange and yellow hairs, curving upwards so as nearly to conceal the black tufts between them; below these, along the sides of the body, is a row of horizontal black tufts. On the first and second rings are four long pencil-like black tufts, extending over the head; on each side of the third ring is a similar black pencil, and two which are white placed in the same manner on the sides of the fourth and tenth segments. These larvæ are gregarious; they feed on milkweed (*Asclepia Syriaca*). They are full grown about the month of September, when they leave off feeding, disperse, conceal themselves, and make their cocoons, which mostly consists of hairs. The chrysalis is short, almost egg-shaped, blunt, and rounded off at the hind end, and is covered with small punctures.

"The perfect moth appears between the middle of June and the beginning of July."

Hab.—Mass.; New York.

Halesidota.—Hubner. *Lophocampa.*—Harris.

Palpi stout, porrect, not long; third joint conical, very minute. Primaries long and narrow. Body stout; abdomen smooth, extending beyond the secondaries. Legs stout, smooth; hind tibiæ with four spurs, moderately long.

Table of species:

A. Primaries semi-transparent .... *tesselaris.*
AA. " densely clothed with scales..................
B. Primaries with transverse rows of silvery white spots .... *caryæ.*
BB. Primaries with yellow spots...................... *maculata.*
BBB. " with whitish tawny bordered spots.*fulvo flava.*

H. tesselaris!—Sm. Abb. Figured in Sm. Abb, pl. 75.

Palpi deep yellow, tipped with black. Antennæ brownish-yellow. Head and thorax whitish-yellow; inner edges of shoulder-covers fringed with bluish-green, with the space between the fringes bright yellow.

Primaries semi-transparent, whitish, tinged with ochre-yellow, with five irregular transverse dusky bands, edged on each side with delicate blackish lines.

Secondaries paler than the primaries and more transparent.

Abdomen ochre-yellow above, paler below. Feet ochre-yellow, spotted with black.

Length of body 5–6 lines. Wings expand 19–20 lines.

Larva: " Head brownish-yellow. Body yellowish-white, with dusky tubercles, from which spring tufts of light yellow or straw-colored hairs, those along the crest being a very little darker: on the second and third segments are two orange colored pencils, which are stretched over the head when at rest, and before these are several long tufts of white hairs. On each side of the third segment is a white pencil, and there are two pencils of the same color on the eleventh segment directed backwards. They are gregarious, and feed upon the buttonwood or sycamore tree, upon which they may be found in July and August. In August or September they leave the trees and secrete themselves under logs, stones, &c., and construct their cocoons, which are oval, thin, and hairy."

Hab.—London, not common; Port Stanley (Mr. Edwards); Montreal (Mr. D'Urban.)

H. caryæ!—Harris. Figured in Harris' Insects, Mass., new edition, fig. 175. H. annulifascia.—Walker. C. B. M., 374.

Palpi dusky yellow, with a minute black dot at the tips. Antennæ deep brownish-yellow. Head and thorax pale ochre-yellow. Shoulder covers edged internally with pale brown.

Primaries pale ochre-yellow, thickly covered with minute brownish dots; two oblique brownish streaks passing backwards from the costa, the inner one most distinct, and three or four irregular transverse rows of silvery white spots, edged with brown; veins brown.

Secondaries paler, semitransparent, and without spots.

Under surface paler than upper; primaries with the same markings, more distinct towards the apex.

Abdomen bright ochre-yellow above; under surface paler, with three longitudinal rows of light brown spots; legs brownish-yellow.

Length of body 6–7 lines. Wings expand 19–21 lines.

Larvæ: "Length one and a-half inches. White, sprinkled with black dots, and covered with short spreading tufts of white hairs, with a row of eight black tufts on the back, and two long, slender black pencils on the fourth and on the tenth segments. The tufts along the top of the back converge on each side so as to form a kind of ridge or crest; and the warts from which these tufts proceed are oblong, oval, and transverse, while the other warts on the body are round. The hairs on the fore part of the body are much longer than the rest and hang over the head; the others are short as if sheared off, and spreading. The head, feet, and under surface are black, and the spaces between the segments have transverse black lines. They feed on hickory, ash, and elm trees; are full grown in September, when they secrete themselves and make their cocoons, which resemble those of the last species."

The perfect insect appears late in May or early in June.

Var. Primaries much darker in color, giving a greater prominence to the silvery white spots; under surface also darker, with markings more distinct.

Hab.—London, common; Toronto (Mr. Bethune); Prescott (Mr. B. Billings); Montreal (Mr. D'Urban).

H. maculata !—Harris. Ins. Mass., p. 259.

Palpi yellow. Antennæ brownish-yellow. Head and thorax deep ochre-yellow.

Primaries yellowish-brown, paler towards the hind margin; with three or four very irregular transverse bands of pale yellow spots, which are largest along the costa, at base, and along the inner margin.

Secondaries whitish, semitransparent, and without spots.

Under surface paler with the markings much less distinct.

Abdomen tawny-yellow above, somewhat paler below with a few brownish dots along the sides. Legs yellow; tarsi tipped with black.

Length of body 7 lines. Wings expand 16 lines.

The larva, as described by Harris from a shrivelled specimen, "is covered with whitish tufts forming a crest on the back, in which are placed eight black tufts; a black pencil on each side of fourth and tenth segments, and a quantity of long white hairs overhanging the head, and the hinder extremity. Head black."

Hab.—London, not common; Cobourg (Mr. Bethune); Kingston (Mr. Rogers).

**H. fulvo flava.*—Walker. C. B. M., 733.

"Proboscis tawny. Thorax with two tawny stripes which converge hindwards, and with two tawny spots in front between the stripes.

"Primaries yellow with a tawny spot at the base, with two oblique tawny bands, with darker borders; these bands are partly connected; and the inner one is especially irregular and ramose, being forked in front, and dilated in the disk, towards the base, and emitting a branch to each border.

"Secondaries whitish with a slight testaceous tinge.

"Femora and tibiæ hairy; fore femora and fore tibiæ tawny above.

"Length of body 6–7 lines. Wings expand 16–18 lines."

Var. "Primaries tawny with yellow spots at the base, at the tips, along the costa, and forming an oblique band beyond the middle."

Hab.—North America.

It is probable that this species is identical with "*maculata.*"

Ecpantheria. *Walker.*

Proboscis moderately long. Palpi very short, not extending beyond the clypeus. Antennæ of *Male* serrated, of *Female* simple. Wings moderately broad. Primaries much longer than secondaries. Body stout. Abdomen extending beyond the hind wings. Legs stout; hind tibiæ with two minute apical spurs.

E. scribonia!—Stoll. *Macularia,* Fab. cram. *Oculatissima,* Sm. and Abb. *Chryseis,* Godart. Figured in Sm. Abb., pl. 69, Nat. Lib. vol. 37.

Palpi dark brown above, whitish below. Antennæ black above, lighter below. Head white, with a wide blue-black band across the front. Thorax white with ten or twelve black rings centred with bluish-white.

Primaries white with numerous dark brown rings and spots, arranged in five or six illy defined transverse bands.

Secondaries white with few spots, chiefly along the hind margin; inner margin very hairy with a blackish stripe.

Under surface somewhat paler than upper with the markings distinct.

Abdomen bluish-black with a metallic gloss; a dorsal row of orange spots and a macular band of the same color along each side; also somewhat banded between the segments with orange; under surface whitish, with three rows of black spots. Legs white spotted with black; anterior thighs blue-black in front.

Length of body 8–10 lines. Wings expand 24–30 lines.

Larva: Length two and a half inches. Head bilobed, black and shining; reddish at the sides. Body black; each segment with a transverse row of elevated tubercles from which spring tufts of rigid, black, shining hairs. Sides brownish-black near under surface with tufts of hair of same color. The spaces between each segment from fourth to tenth inclusive are banded with red, bands wider and more conspicuous from sixth to ninth. Color of under side varies from reddish to yellowish-brown ; feet reddish ; legs brown, thickly clothed with short hairs.

These larva attain their full growth in the autumn, when they may be found feeding on the wild sunflower, and hybernate through the winter under logs, the loose bark of decaying trees, &c. When aroused from their torpor by the warmth of spring, they feed a little on almost any green thing they meet with, before going into chrysalis. They will feed readily on grass. They enter the chrysalis state about the last of April or beginning of May, and the perfect insect is evolved early in June.

Var. Thorax with bluish-black spots instead of rings ; abdomen tipped with white ; dorsal row of orange spots wanting.

Hab.—London, not common ; St. Catherines (Mr. Beadle) ; Port Stanley (Mr. Edwards).

Phragmatobia. Stephens.

Palpi short, scarcely distinct, very pilose. Antennæ short ; of the *Male* serrate, of the *Female* simple. Head and thorax with long hairs. Wings semitransparent. Body stout. Abdomen maculate. Anterior tibiæ unarmed ; posterior tibiæ with four spurs.

Table of species :

A. Primaries red, with brown markings.............. *assimilans.*
AA. " brown.. *rubricosa.*

*P. assimilians.—Walker. C. B. M., 630.

"*Male.* Red. Antennæ testaceous. Thorax with brown hairs.

"Wings red ; veins darker. Primaries slightly brown along the costa, and elsewhere indistinctly sprinkled with pale brown, with two blackish dots.

"Secondaries brighter red, with three black dots, two on the disk, and one near the hind border towards the inner angle.

Length of body 6 lines. Wings expand 16 lines."

Var. "Primaries almost wholly brown. Secondaries with a broad blackish submarginal stripe."

Larva undescribed.

Hab.—United States.

P. rubricosa !—Harris. Arctia rubricosa, Harris' Insects ; new edition.

Antennæ whitish. Palpi, head and thorax dark reddish-brown.

Primaries dull reddish-brown, with the discal cell terminated by a blackish line, enlarged into a dot at each end.

Secondaries paler in color than primaries, with a rosy tint becoming blacker behind. Inner margin and fringe of hind margin red.

Under surface of both primaries and secondaries reddish excepting along the hind margins. The lines which, on the upper surface, unite the dots on discal nervure, wanting.

Abdomen red, with dorsal and lateral rows of black spots ; under surface dull reddish-brown. Fore femora bright red.

Length of body 4–5 lines. Wings expand 11–12 lines.

The larva has been reared by D. W. Beadle, Esq., of St Catherines, who has kindly furnished me with the following notes : "They were found in the fall, feeding on a young ash tree, near St. Catherines ; they spun a web over nearly the whole of the tree before they had done feeding, spinning as they fed, so as to keep themselves covered. The web is not so dense as that of Clisiocampa Americana.—The larvæ were of a dingy smoke color, deepening into a dark brown. Hairs not stout and bristle like, as in '*S. Isabella,*' but finer and softer, like '*virginica.*' The perfect insect did not appear until the following spring."

Var. Secondaries reddish pink ; hind margin widely bordered with dull blackish.

This species closely resembles the European "*fuliginosa,*" and has usually been regarded as identical with it ; Harris, however, held a different view, and named it rubricosa. The habits of the larvæ appear to be different, and there are slight differences also in the markings on the wings. In "*fuliginosa,*" the black dots on wings are more prominent, and the red on secondaries much deeper and brighter in color. In "*rubricosa*". the secondaries are margined behind throughout with black, whereas in fuliginosa the red color of the ciliæ encroaches upon the wing, especially towards the apex ; and the black is somewhat broken towards the anal angle into irregular spots ; in the latter also the primaries are somewhat less transparent, and the dorsal spots on abdomen coalesce forming a macular band.

Hab.—St. Catharines, (Mr. Beadle). Hamilton, (Mr. Reynolds), Matan. Gulf of the St. Lawrence, (Mr. Bell). St. Martin's Falls, Hudson's Bay Territory, (Dr. Barnston.)

Deiopeia Curt.

Body slender. Head small. Eyes prominent. Antennæ simple in each sex; rather short and slightly pilose beneath in the males.—Palpi curved, ascending nearly to the middle of the face, basal joint tumid, middle joint long, terminal joint short, ovate. Tongue about equal to the thorax beneath. Legs moderate, tibiæ very short, hind tibiæ with four spurs at the apex. Flight diurnal.

D. bella !—Linn.

Palpi yellowish-white, tipped with black. Antennæ black. Head whitish, with four black spots. Thorax white, with about twelve black spots; and a patch of ochre-yellow on each side, at base of primaries.

Primaries orange-yellow, with from five to seven irregular transverse whitish bands, spotted in the middle with black; the last one furcate from about the middle towards the costa; hind margin with a row of black spots.

Secondaries bright red, sometimes paler; with the hind margin bordered with a black-white edged indented band, which is furcate at the apex of the wing.

Under surface very bright red; primaries with the costal margin yellow; three elongated black spots extending from the costa inwards; a subterminal imperfect black band and a row of spots on the hind margin. Secondaries with the same markings as above, with two white bordered black spots on the costal margin.

Abdomen greyish-white, with two rows of black spots on the under side. Legs whitish, spotted with black.

Length of body 6 lines. Wings expand 13 lines.

Larva undescribed.

Var. Primaries with the white stripes from the base to beyond the middle intersecting the orange bands, dividing them into two or three portions.

Hab.—London. Rare. St. Catherines, (Mr. Beadle). Keswick, Lake Simcoe, both type and var., (Mr. Bethune.) Port Stanley, (Mr. Edwards.)

Hypercompa Hubn. Callimorpha Latr.

Palpi somewhat exceeding the clypeus, pilose towards the base, the middle and basal joints nearly equal, terminal joint short and ovate. Tongue about the length of the thorax beneath. Eyes large and prominent. Antennæ simple in both sexes, ciliated with two strong seta at each joint. Thorax smooth. Body slender. Secondaries broader than primaries. Legs rather slender, anterior tibiæ much shorter than the femora; hind tibiæ with four moderate spurs. Flight diurnal.

Table of species:

A. Secondaries white.
  B. Primaries white with a transverse dark brown band beyond the middle. *contigua.*
  BB. " " with the costal edge yellow orange... *fulvicosta.*
  BBB. " " with a brown band from the inner margin to the tip *militaris.*
    C. Primaries brown with white spots... *Lecontei.*
    CC. " " with an oblique subapical white band .... *confinis.*
AA. Secondaries yellow.
  D. Primaries dark brown, with whitish spots; secondaries pale yellow .... *clymene.*
  DD. " pale buff, bordered with brownish-black; secondaries, deep yellow .... *interrupto-marginata.*

H. contigua !—Walker. C. B. M., 650.

Palpi orange-yellow, tipped with black. Antennæ brownish-black, somewhat lighter below. Head and front edge of thorax deep yellow. Thorax brownish-black, with the sides and shoulder covers white.

Primaries white with blackish-brown stripes; one along the costa to near the tip; one on the inner margin, joined at its extremity with an oblique transverse band, extending to the costa; from the centre of this latter a stripe extends to the hind margin, somewhat enlarged at its termination, where it is centered with white. Hind margin partially edged with brownish-black.

Secondaries white, immaculate.

Abdomen white, with a blackish dorsal stripe extending nearly to the tip. Fore femora yellow; legs whitish, fore and middle pairs edged anteriorly with black.

Length of body 6–7 lines. Wings expand 17–18 lines.

Larva undescribed.

Var. Secondaries with two or three brownish spots near the anal angle.

Hab.—London, not common; Grafton, Co. Northumberland (Mr. Bethune); United States.

**H. fulvicosta.*—Clemens. Clemens Contributions to Amer. Lepidopterology. Proc. Acad. Nat. Sci.

"Palpi yellow-orange, tips blackish. Head and prothorax yellow-orange. Thorax white.

Primaries white with the costal edge, especially beneath, yellow-orange, sometimes brownish.

Secondaries white.

Abdomen white, tipped with yellowish. Breast and legs yellow-orange, the middle and fore tibiæ and tarsi blackish."

Larva undescribed.

Hab.—Illinois.

**H. militaris.*—Harris. Figured in Harris' Insects, new edition, fig. 165.

"Head and collar buff-yellow. Thorax and abdomen with a dorsal brown stripe.

Primaries almost entirely bordered with brown, with an oblique band of the same color from the inner margin to the tip; and the brown border on the front margin has two short irregular projections extending backwards on the surface of the wing.

Secondaries white without spots.

Thighs buff-yellow.

Wings expand 18–20 lines."

Larva undescribed.

Hab.—Massachusetts.

H. Lecontei !—Boisd. (C. militaris ? Var. Lecontei.)

Palpi deep orange-yellow, tipped with black. Antennæ black. Head orange-yellow. Thorax whitish with a wide central brown stripe.

Primaries vary in color from very light to dark brown, with from four to six large irregular white spots and two or three smaller ones.

Secondaries white, sometimes with one or two brown or blackish dots towards the anal angle.

Under surface of primaries with the costal edge, and brown markings towards the apex orange-yellow.

Abdomen yellowish-white tipped with yellow. Legs ochre-yellow, striped and spotted with black.

Length of body 6–7 lines. Wings expand 16–17 lines.

Larva undescribed.

Hab.—London, common; St. Catherines (Mr. Beadle); West Flamboro' (Mr. Bethune); Port Stanley (Mr. Edwards.)

This moth, which is usually regarded as a variety of the preceding species, has been described separately under Boisduval's name "Lecontei" for the following reason: That while this so-called variety is common in many localities throughout the Province, I have never yet met with a single specimen at all approaching the description and figure given of "*militaris*" in "Harris' Insects;" a fact exceedingly remarkable if the former is merely a variety of the latter.

**H. confinis.*—Walker. C. B. M., 661.

"Proboscis tawny. Palpi with black tips. Antennæ black. Head, prothorax, fore coxæ, and abdomen at the base luteous. Thorax and abdomen white with a brown stripe.

Primaries brown, with a discal slightly angular white stripe, and an elongate, triangular, oblique, subapical white band.

Secondaries white.

Length of body 6 lines. Wings expand 18 lines."

Larva undescribed.

Hab.—United States.

H. clymene !—Esper. Colona Hubner.

Palpi ochre-yellow tipped with brown. Antennæ brownish-black. Head and prothorax orange-yellow. Thorax yellowish-white with two small spots in front, and a wide central band black.

Primaries brownish-black, with four or five large white or yellowish-white spots, and one or two small ones.

Secondaries light yellow with a brown spot near the anal angle.

Under surface of primaries with markings as above but much paler and overcast with yellow. Secondaries deeper in color than above.

Abdomen pale yellow with the tip of a deeper color, and a dorsal line of black. Legs yellow, the fore and middle pairs edged with black.

Length of body 6 lines. Wings expand 17–18.

Larva undescribed.

Hab.—Near West Flamboro'. Captured at midday in August. (Mr. Bethune.)

H. interrupto-marginata !—Beauv. Carolina, Harris. C. comma, Walker, C. B. M., 652. Bornlix interrupto-marginata. De Beauvois, Ins. Afriq. et Amer., p. 265, pl. 24.

Palpi deep ochre-yellow with black tips. Antennæ brown. Head pale orange-yellow. Thorax yellowish or pale buff, with a wide central black stripe, and a black spot on each side at base of primaries.

Primaries pale buff, with a black stripe along the costa not reaching the apex; a broad stripe of the same color along the inner margin, widening near the tip and sending from near the inner angle towards the hind end of the disk a hooked demi-band; hind margin with an incomplete black band, widest in the middle.

Secondaries bright orange-yellow with a black spot not far from the anal angle.

Under surface deep yellow througbout, with the markings on primaries excepting the demi-band scarcely perceptible.

Abdomen orange-yellow, with a dorsal band black. Legs deep yellow; the fore and middle pairs edged anteriorly with black.

Length of body 6–8 lines. Wings expand 16–20 lines.

Larva undescribed.

Hab.—London, rare; St. Catherines (Mr. Beadle); Port Stanley (Mr. Edwards); Wisconsin, and Virginia.

REVIEWS.

The Geological Evidences of the Antiquity of Man, with Remarks on Theories of Species by Variation. By Sir Charles Lyell, F.R.S. London: John Murray, 1863.

There are certain questions and debatable points of inquiry, belonging to the domain of Science, which awaken, from their very nature, an almost equal amount of interest on the part of the general public, and on that also of the anti-scientific world—using this latter term, in default of a better, to designate a class, at one time numerous, though now reduced in parliamentary phrase, to a small but active minority, which regards (without actually confessing it) the revelations of Natural Science as directly or indirectly antagonistic to the authority of Biblical acceptations. Amongst these questions, the date of Man's origin occupies a prominent place. The usual belief fixes the creation of Human Life at about six thousand years before the present era; but theologians differ amongst themselves with regard to the precise date. The gathered records of Geology have long been tending towards another conclusion: one that attributes to our race a far higher or more remote antiquity; and the principal aim of Sir Charles Lyell's book is to present a clear and forcible exposition of this view, based on the results of recent discovery and research. The book, however, has, apparently, a two-fold aim: one to maintain the high antiquity of Man; and the other, to make this antiquity subservient to the support of the so-called Darwinian theory with regard to Man's origin. Postponing, for the present, the discussion of this latter view, let us briefly examine the more important facts, thus brought together, in support of the assumed presence of Man upon the earth at a period incalculably remote as compared with the known points of human history. In order to exhibit these facts to the general reader, in their true bearings on the question under review, it will be necessary to carry our retrospective glance still farther into the depths of Time, and to trace up the course of geological history, from the remote epochs which preceded the dawn of life, to the period of Man's advent, when the geology of the Past blends with and gradually merges into the geology of the Present.

Speculation, supported by many facts that point in the same direction, pictures the primary condition of the earth—equally with that of other cosmical bodies—as one of nebulosity, gradually condensing towards the solid state, and eventually passing into this, as regards the surface of the earth-mass. Although the rock-matters resulting from the first consolidation, must long have disappeared, or have lost altogether their original characters, a period would finally arrive when a certain degree of stability—or rather a more equal balance between destructive and formative forces—would be approached. This would arise, when by the continued radiation of heat into space, the earth's crust became sufficiently thick to admit of the condensation of water upon its surface. Then a new set of phenomena would appear. The exposed rock-surfaces would be slowly worn down by aqueous and atmospheric agencies, and the materials, thus obtained, would form over the sea-bed a gradually increasing thickness of stratified deposits. Many of these rocks, though mostly in an altered or metamorphic condition, have been preserved to us. They contain no vestiges of organic forms, vegetable or animal. Life, as yet, held no place upon the earth; and as these strata, even as now seen, present a thickness of many thousands of feet, it is evident that this first or Azoic period of the Earth's history was one of almost immeasurable length.

The busy agents of Decay and Renovation, those old but yet unreconciled antagonists that have made Nature their battle-field from all time, still continued their active and unceasing strife. The older rock-masses furnished the sediments for the formation of newer strata; but in these latter, we find the records of a wonderful change, witnessed by the Earth at the close of its azoic day. To the strange mystery of the Earth's presence, the still stranger mystery of *Life* had now been added. The organic remains enclosed within these earliest fossiliferous rocks, are of comparatively low types. Fucoids, brachiopods, trilobites, constitute the more characteristic forms: the vertebrated life-structure is entirely absent. A little higher in the series, a little later in the course of time, plants of terrestial growth, fishes, and obscure reptilian types, make their appearance, together with powerful tetrabranchiate cephalopods and other forms of an extinct or rare organization, as compared with the life-forms of existing seas. Strata still succeed strata, as newer sediments are spread along shore-lines, in bays, and over the sea-bed. Many of the earlier types, or those enclosed in the lower rocks—graptolites, trilobites, and others—die out, not gradually as it were, as though the organic pattern were changed by gradual modification, but abruptly, at fixed stages in the rock series, before the close even of this first life-period, the great Palæozoic Age. To this, and some related points, we shall have occasion to allude again, in the sequel. At present, we may observe, that, with the exception of a few reptiles of comparatively low station, fishes appear to have been the most highly organized vertebrates or leading forms of palæozoic development. These fishes, even those with bony skeleton, had, throughout, unequally-lobed tail-fins; and their scales (when present) were of a solid osseous character: a peculiarity of structure now all but unknown.

A third epoch of the Earth's history, the second of its great life-periods, is characterized by a remarkable development of reptilian forms of varied and high organization. Some of these belong to marine, natatory types: frequenters of the open ocean: representatives, not in structure, but in character, of the great predatory sharks of modern seas. Another presents a winged, bat-like structure, and its species are amongst the most curious of extinct forms; whilst carnivorous and herbivorous mammals, as now existing, were represented in their functions by other reptilian types of this Mesozoic Age. Combined with these, and equally characteristic of the period, are numerous Ammonites, and other related cephalopods with foliated or highly complicated shell-partitions. All of these, and other peculiar types—reptilian, molluscous, &c.—became extinct with the closing of the geological age in which they had their being. But in addition to these modifications, foreshadowing, as it were, the advent of a higher time, a few rare and more or less obscure indications of mammalia occur amongst the organic remains preserved in Mesozoic rocks. The best known appear to present characters most nearly allied to marsupial or didelphian mammals, the lower of the two great parallel series into which the mammalian class admits of being sub-divided. In this age also, a remarkable change occurs in the representatives of fish-life. Homocercal forms appear; and a little later, the rapidly diminishing ganoids are all but replaced by teleosteans of modern type.*

Then another scene appears, and the new geological period heralds the dawn of that condition of Nature which we now see around us.—Reptiles form no longer the great leading types of the animal world. The strange creations of the Mesozoic day have all disappeared, and the Earth is now abundantly tenanted by representatives of a higher class, typifying all existing orders of Mammalia save that to which

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* It may be observed, for the information of the general reader, that amongst the few remaining ganoids now in existence, the *Lepidosteus* or 'gar pike' of the lakes and rivers of North America, is one of the most characteristic examples. Specimens, easily distinguished from other fishes by their enamelled and rhombic scales, may be seen in any museum.

Man alone belongs. Many of these forms, not only as species, but as genera, are quite extinct: but none appear to have belonged to absolutely extinct orders. In its vegetation also, the Earth of the Cainozoic Age presents much that is common, in its general features, with the arborescent vegetation of existing Nature. A general similarity indeed, between that period and our own, is visible throughout all the sub-divisions of the organic world; but the physical and climatical relations of the earlier time differed in many marked respects from those which now prevail. Up to a comparatively late interval, the Cainozoic earth appears to have possessed a more or less uniform and warm climate, without those broad distinctions, derived from geographical position, which are now experienced. This view is amply sustained by fossil evidence. In the comparatively high latitude of England and Northern Europe generally, not only do we find the shells of *conulariæ*, *nautili*, and similar warm-sea mollusca; but the Cainozoic rocks of these districts contain also palm-fruits, together with the remains of large ophidians and skeletons of mammals allied to the modern tapir, hippopotamus, giraffe, and other forms—including even the quadrumanous type—now limited, or nearly so, to intertropical habitation. As time passed on, however, a great climatic change crept slowly over all the northern lands of both the eastern and western continents, and was apparently experiencad also, in the extreme southern regions of the latter. Under its influence, the once warm climate gave gradually place to all the rigors of an Arctic winter.—This remarkable change was evidently accompanied, and perhaps in chief part produced, by enormous alterations in the previously-existing levels of land and sea. A general elevation of northern districts, and a corresponding depression (with subsequent elevation) of the adjacent and more southward-lying country, must have taken place at one epoch of this period of cold, during which, the drift and boulder deposits, with their accompanying glacial phenomena, were slowly elaborated. All the high lands were covered by broadly-extended glaciers; and the seas were filled with floating icebergs, bearing southwards the gneissoid and other boulders of the north. This condition of things probably continued throughout a long interval of time.—During its continuance, nearly all the animal and vegetable species of the preceding epoch became extinct, but some few survived its changes. Between its close, and the commencement of the present state of things no strict line of demarcation can be drawn. The one merged slowly into the other: the glacial manifestations being gradually beaten back, as it were, to within their present arctic and alpine boundaries.

Above the clay, gravel, and boulder deposits accumulated during this interval of cold, lie various other beds of clay, loam, sand, and gravel, accompanied locally by bog-iron-ores, calcareous tufa, peat, and sundry related matters of comparatively modern origin—many of these beds, indeed, being still under process of formation. Great changes of level have been continually going on during the accumulation of these different materials; and portions of the original sea-bed have been raised high above the water-line, at various localities. Gravel deposits containing marine shells of existing species occur, for example, at considerable heights on the coasts of Norway and Sweden, in Eastern Canada, Maine, and numerous other places. On the south coast of the Island of Sardinia, an ancient sea-bed, containing shells of the modern oyster and mussel, with fragments of pottery and other wrought objects, occurs at a height of between two and three hundred feet above the present sea-level. These deposits in many places, moreover, exhibit in themselves a thickness of over a hundred or even two hundred feet. It is evident, therefore, that although recent in a geological sense, many ages must have rolled away since the commencement of their accumulation. Sir Charles Lyell, in the work before us, basing his calculation on the known rate of uprise of the Scandinavian coast, computes a period of at least 12,000 years for the elevation alone of the Sardinian sea-beach; and the unknown interval before the commencement of the upward movement, and that which has elapsed since its close, must be added to this, in attempting to fix the date of the imbedded pottery. Based on a similar calculation, the shell-beds of the Norwegian coast are assumed to have occupied in their upward passage from their original place of deposition, an interval of no less than 24,000 years. And yet these are amongst the latest geological records of the Earth's history: even subsequent in some instances, as proved by the Sardinian pottery, to the actual appearance of Man.

The shells of marine and fresh-water mollusca, enclosed in these recent geological deposits, belong, as already stated, to existing species, although some are no longer met with in the localities at which the deposits in question occur. The mammalian remains preserved in these accumulations are likewise referrible in great part to existing forms; but some are altogether extinct. The more remarkable of the latter, in the eastern continent, comprise: the *mammoth* and some other species of the elephant, the *Rhinoceros tichorinus, Hippopotamus major, Equus fossilis, Cave-Lion* (*Felis spelœa*), *Cave-Hyena* (*Hyena spelœa*), *Cavern-Bear* (*Ursus spelœus*), *Irish Elk*, &c.; and on this continent, the *mammoth, mastodon, megatherium, mylodon, megalonyx, glyptodon,* and others. In some parts of Europe, more especially in the valleys of the Somme and Oise in north-western France, and in parts of Suffolk, Bedford, Essex, Kent, and Surrey, in England, remains of these extinct elephantine and other species have been discovered in gravel, or similar deposits, associated with knife-blades and other flint implements of rude form. This of itself would not absolutely prove the contemporaneity of the extinct mammals, and Man; but the flint weapons in many cases lie deeper in the earth than some of the animal bones; and these latter are occasionally seen to have been cut (when in a fresh state) by instruments of a comparatively rude construction. The weight of evidence, therefore, is strongly in favour of the view, that Man was actually a denizen of the earth long before the mammoth and its congeners became extinct. A link, and that an important one, in this train of evidence, it is true, is yet wanting. No human bones have hitherto been discovered with these flint implements and extinct remains in the gravel deposits of the above localities.* Several causes have been assigned to account for this apparent discrepancy, but none are of a very satisfactory character. Nevertheless, under other, though at the same time closely related conditions, human remains have been met with somewhat abundantly in intimate association with the bones of extinct mammals. This occurs, for example, in numerous caverns, in which the organic matters have been preserved from final decomposition by a protecting layer of stalagmite. But here, again, it might be urged that the bones, with which these caverns are filled, are not of contemporaneous origin. In some instances this is undoubtedly the fact. The caverns often formed the lairs of wild animals, the bones of which, with those of their prey, are imbedded in the stalagmitic matters of the floor. But in many localities the human bones are so mixed with those of *felidæ* and other animals, as to leave but little doubt of the contemporaneous origin of the whole. If an accidental tooth of the mammoth, a solitary skull of the cavern bear, or scattered bones, only, of the cave-hyena or lion, were mingled with the human relics, we might conceive the former to have been swept into these receptacles by floods acting on loosely-consolidated sediments in which the animal remains were previously contained; but these remains are far too abundant to admit of such a conclusion. The question, moreover, has to a great extent been set at rest, by some comparatively recent discoveries in the south of France, made known, during the course of last year, by M. Lartet. Near Aurignac, in the department of the Haute Garonne, a small cavern occurs on the sloping side of a hill, in which many human and extinct animal remains, mixed with some of existing species, were discovered in a remarkable state of preservation. The mouth of the cavern was concealed beneath a talus of detrital matter, washed down from the top of the hill; and on this being removed, a large slab of rock was found to have been placed vertically before it so as to defend the entrance. It was clear, consequently, that the cavern had been filled by human agency; and further explorations shewed it to have been a place of sepulture. The human bones are thought to have belonged to no less than seventeen individuals of different ages and of both sexes. A great number of flint knives, pieces of perforated shell, and other wrought articles, were also found within the cave; and on the outside of the vertical slab of rock, partially burnt and broken bones of various animals, mixed with ashes and other matters, were discovered in some abundance, but without any intermixture of human bones. Hence it is conceived that the animal remains within the cavern were derived from beasts, slaughtered and placed there, after the custom of most savage nations, during the sepulchral ceremonies; whilst those without the cavern entrance are thought to have resulted from the accompanying funeral feasts. The human skulls of this cavern were buried in the cemetery at Aurignac, some time before M. Lartet's visit to the spot, and the exact place of their interment could not be afterwards ascertained. They were examined, however, by a surgeon, the mayor of Aurignac, when first obtained, and they do not appear to have offered any exceptional characters. This is also the case with regard to most of the skulls obtained from various other caverns in which human remains have been found; but in some, an occasional skull of a more than ordinarily low type has been met with. The most remarkable of these is the now celebrated cranium from a cave near the Neuderthal, not far from Düsseldorf. This presents, according to Huxley and other competent observers, a very ape-like character: a fact which has been seized upon by the supporters of the Darwinian theory, as strongly confirmatory of their views regarding the assumed relationship of progression between the Quadrumana and Man. An interpretation of this kind, however, based on the examination of a single skull, or other equally imperfect data, is, at least, premature. To substantiate the theory, a much larger amount of evidence is assuredly required: and even if the majority of cavern skulls exhibited a simian aspect, the question would still remain unproved, since the existence of a *structural relationship* between the ape and man, as between all forms of the same general type, is necessarily and universally admitted. But on this subject we shall have more to say as we proceed.

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* Since the above was written, the discovery of a human jaw-bone in the gravel pit of Moulin-Quignon, near Abbeville, has been announced; but the assumed antiquity of this bone is exceedingly doubtful.

Keeping, at present, to the first question, we have no hesitation in regarding the extinction of the mammoth and other departed forms of the Post-Tertiary period, as long subsequent to the appearance of Man. This alone would prove the high antiquity of our race: since the extinction of these types cannot be supposed to have taken place in any sudden manner; more especially when we consider the great abundance of their remains, as those of the mammoth for example, in so many localities. Their extinction, though aided to some extent by the agency of man, was undoubtedly the work of slow physical changes, going on continuously throughout a long series of ages. This conclusion, as bearing on the antiquity of our species, is in harmony with that drawn from the uprise of the ancient sea-beach (containing relics of man's industry) on the Sardinian coast.

And other proofs of this antiquity are still forthcoming. Amongst the more interesting, we may refer to the curious facts gleaned from the so-called "refuse-heaps" or "shell-mounds" of Denmark, and from the great peat-deposits of the same country, as described in one of the earlier chapters of the work before us. At certain points along the coast of Denmark, writes Sir Charles Lyell "mounds may be seen consisting chiefly of thousands of cast-away shells of the oyster, cockle, and other mollusks of the same species as those which are now eaten by man. These shells are plentifully mixed up with the bones of various quadrupeds, birds, and fish, which served as the food of the rude hunters and fishers by whom the mounds were accumulated. Such accumulations are called by the Danes, *Kjökkenmödding* or "kitchen-refuse heaps." Scattered all through them are flint knives, hatchets and other instruments of stone, horn, wood and bone, with fragments of coarse pottery, mixed with charcoal and cinders, but never any instruments of bronze, still less of iron. The stone knives are sharpened by rubbing, and in this respect are one degree less rude than those of an older date, associated in France [and in England] with the bones of extinct mammalia. The mounds vary in height from three to ten feet ; and in area, some of them are 1,000 feet long, and from 150 to 200 wide. They are rarely placed more than ten feet above the level of the sea, and are confined to its immediate neighbourhood, or if not (and there are cases where there are several miles from the shore), the distance is ascribable to the entrance of a small stream, which has deposited sediment, or to the growth of a peaty swamp, by which the land has been made to advance on the Baltic, as it is still doing in many places, aided, according to M. Puggard, by a very slow upheaval of the whole country, amounting to two or three inches in a century. There is also another geographical fact equally in favour of the antiquity of the mounds, viz., that they are wanting on those parts of the coasts which border the Western Ocean, or exactly where the waves are now slowly eating away the land. There is every reason to presume that originally there were stations along the coast of the German Ocean as well as that of the Baltic, but by the gradual undermining of the cliffs they have all been swept away. Another striking proof, perhaps the most conclusive of all, that the "refuse-heaps" are very old, is derived from the character of their embedded shells. These consist entirely of living species ; but, in the first place, the common eatable oyster is among them, attaining its full size, whereas the same *Ostrea edulis* cannot live at present in the brackish waters of the Baltic except near its entrance, where, whenever a north-westerly gale prevails, a current setting in from the ocean pours in a great body of salt water. Yet it seems that during the whole time of the accumulation of the shell-mounds the oyster flourished in places from which it is now excluded. In like manner, the eatable cockle, mussel, and periwinkle, which are met with in great numbers in the "refuse-heaps," are of the ordinary dimensions which they acquire in the ocean ; whereas the same species now living in the adjoining parts of the Baltic, only attain a third of their natural size, being stunted and dwarfed in their growth by the quantity of fresh-water poured by rivers into that inland sea. Hence, we may confidently infer that in the days of the aboriginal hunters and fishers, the ocean had freer access to the Baltic than at present."

The bones of mammalia enclosed in these refuse-heaps belong entirely to existing forms, with the exception of one species, the *Bos*

Urus: and the latter, it is well known, survived to within a comparatively recent epoch. Although of ancient date, therefore, as proved by the changes in the surrounding physical conditions which must have taken place since their accumulation, they belong to a less remote period than the gravel beds of Amiens and other localities alluded to in an earlier part of this notice. In the peat-bogs of Denmark, we find evidences of a still more recent origin, coupled, however, with facts which shew how vast must have been the lapse of time between even these latest records, and the earliest known days of northern history. The three successive periods of stone, bronze, and iron, are clearly revealed in these peat accumulations as in those of many other countries. But each of these periods in Denmark was accompanied by a special forest-vegetation of its own: and in this lies the chief interest of the Danish peat-bogs—the physical changes which these so clearly indicate, being in themselves an undeniable record of the long periods which must have elapsed since the first stone implement became imbedded in the peat-morass. The lower beds, a few feet in thickness, rest in hollows on the surface of Drift deposits, and contain, with flint knives and other implements of stone, numerous trunks of trees, some three feet in diameter, belonging chiefly to the *Pinus sylvestris* or Scotch Fir. This tree has never been seen in Denmark within historical times, except here and there as an introduced species; and the climate at present is quite unsuited to its growth. The succeeding peat-beds contain two varieties of the oak, now almost extinct within the Danish Isles; and mixed with these, more especially towards the upper part of the deposit, hatchets and other implements of copper and bronze have been found. Finally, in the highest stratum of the peat, the oak trunks are replaced by stems of the common beech, the tree of which the present forests of Denmark are chiefly composed.—"In the time of the Romans"—writes Sir Charles Lyell—"the Danish Isles were covered, as now, with magnificent beech forests. Nowhere in the world does this tree flourish more luxuriantly than in Denmark; and eighteen centuries seem to have done little or nothing towards modifying the character of the forest vegetation. Yet in the antecedent bronze period there were no beech trees, or at most but a few stragglers, the country being then covered with oak. In the age of stone, again, the Scotch fir prevailed, and already there were human inhabitants in those old pine forests. How many generations of each species of tree flourished in succession before the pine was supplanted by the oak, and the oak by the beech, can be but vaguely conjectured; but the minimum of time required for the formation of so much peat must, according to the estimate of Steenstrup and other good authorities, have amounted to at least 4,000 years; and there is nothing in the observed rate of the growth of peat opposed to the conclusion that the number of centuries may not have been four times as great, even though the signs of man's existence have not yet been traced down to the lowest or amorphous stratum."

With regard to the Lamarckian or Darwinian hypothesis, of which a general sketch is given in the latter part of his book, and to the bearings of Man's antiquity on this theory, the author expresses himself in somewhat indefinite terms, but with a manifest bearing towards an acceptation of Darwin's views. There is a good deal of book-making, however, in this part of the volume; merely a general resumé of the subject being given, without the elaboration of any important facts or deductions of a novel character. Having already discussed the leading points connected with this theory, in a recent volume of the Journal,* we need not extend the present notice by any lengthened repetition of the argument. The theory essentially supposes this: that our so-called species, in place of being original creations, are really derivative forms—developed from types of earlier existence by slow accumulative changes, brought about, in themselves, chiefly by a gradual alteration of physical conditions in surrounding Nature.—In other words—an organic form of any kind, is supposed to be subject to indefinite variation: and thus, it is maintained, all existing species have sprung during a long series of ages from a few original life-forms, or even from a single parent-organism. Startling as this view must at first appear, it has nevertheless some strong claims to consideration. The principal of these, confining ourselves to the animal world, are as follows:—First, the structural and functional homologies which obtain, not only amongst nearly related types, but even, to some extent, throughout the whole animal series. Secondly, the resemblance between the progressive phases of fœtal development in higher forms, and the permanent condition of inferior types. And thirdly, the presence of rudimentary or imperfect organs in various species. These facts, which are in perfect harmony with the development theory, constitute grave difficulties when we strive to explain them in connexion with the usually received or "special creation" view. The two first might be met, it is true, by assuming these structural and functional relations to belong to the general plan of creation, conceived and carried out by the Almighty, for some, to us, unfathomable purpose ; but the third, if closely considered, cannot be made amenable to any explanation of this kind. It is useless to urge, moreover, that these imperfect organs may have become so by disuse, in consequence of a change of life produced by accidental conditions, since there are numerous cases to which this cannot be applied. On the other hand, the so-called development theory is beset by equal difficulties. One of the more striking, is the apparent absence, both in existing Nature and amongst the fossil relics of the Past, of any transitional forms, linking together the more strongly marked groups or special types. At present, for example, the reptile and the mammal are quite distinct in all their leading characters, and they appear (zoologically) to have been equally distinct in earlier geological periods.— In other words, the required *parent-types* of this theory, are universally wanting. In our very lowest fossiliferous rocks, again, we find various distinct genera, as strongly separated from each other as these now existing, appearing at one and the same time ; and when a great change in any type takes place, the new forms appear, for the greater part, quite suddenly or abruptly, as instanced amongst other examples, by the nearly total replacement of the Ganoid fishes by true Teleosteans in the Cretaceous epoch. The assumed imperfection of the geological record is brought forward in reply to this ; but granting to a certain extent, the incompleteness of this record, it is at least a damaging fact for the Darwinian theory that the imperfection tells always on one side. Another obstacle to the reception of this theory, is found in the strong sexual antagonism, if such a term may be used, existing between all but the most closely allied forms ; and the *general* sterility of crossed species beyond the first generation. The possession of instinct in certain types ; an unimprovable and unchangeable quality, as pointed out by Darwin himself, is also opposed to the theory ; and we may extend this argument, and urge that the absence of special instincts in other types, is also an objection. Taking two genera, for example, not far removed from each other, as the Bee and the Fly, it is difficult to understand on the development hypothesis, how one comes to possess the hive-building and other accompanying instincts, so strikingly manifested, whilst the other is totally devoid of them.— But apart from all other considerations, the immensity of the break which stares us in the face when we attempt to compare one type with another, even within the limits of the same class—as the whale with the sheep, for instance, and this latter with the beaver or the tiger—is alone sufficient to prevent a present acceptance of the development theory. Between the highest apes and Man, it is true, much closer structural relations are shown to exist; and great weight is attached to this by the followers of Darwin's school. But admitting the full force of these relations, the gulf required to be bridged over is equally great: a dumb and stationary brute-intellect on the one side—speech, reason, and progress, on the other. We may yet say, in the words of Jean Paul, if not in the exact sense in which he used them, "Der Mensch ist der grosse Gedankenstrich im Buche der Natur."

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* Vol. v. pp. 367-387

E. J. C.

On the Origin of Species, or the Causes of the Phenomena of Organic nature: A Course of Lectures to Working Men. By Thomas H. Huxley, F.R.S., F.L.S., Professor of Natural History in the Jermyn St. School of Mines. London: Published. New York: Reprinted; D. Appleton & Co., 443 & 445 Broadway—1863.

This is a publication from the notes of the Short-hand writer, the lectures having been delivered extemporaneously, and the author having had no leisure for their revision, beyond the correction of any important error in a matter of fact. The work has been much read, and has attracted much attention, which is only natural and reasonable considering the varied and accurate knowledge, the high reputation and undoubted talents of its distinguished author, as well as the extraordinary interest excited by Darwin's book, in which the hypothesis was proposed, but although anything coming from Professor Huxley must deserve careful consideration, and is in fact only too likely to be hastily accepted on his authority, the present publication involves such grave questions affecting the very foundations of our scientific inquiries, that we are not disposed to content ourselves with saying that it is an able work deserving of candid examination, but feel bound to enter a little upon the argument, and to express our reasons for not assenting to the hypothesis defended.

There might at the outset be a question raised whether Professor Huxley exercised a wise discretion in the choice of a subject to bring before such an audience as he was to address. He selected a subject very interesting to himself; a controversial subject upon which he entertained a very strong opinion, which he was glad of any opportunity of defending; a subject which is at this time engaging much of the attention of the scientific world, and exciting the curiosity of the public, so as to promise as much popularity as any which could be chosen; but a subject involving the most obscure and difficult questions connected with natural science, and therefore least adapted for those whose ordinary employments prevent their giving much time to such pursuits, and who cannot be presumed to possess the preliminary knowledge requisite for any useful judgment on the points at issue. It may be that Professor Huxley calculated on an audience very different in character from that which he was nominally addressing; it may be that he relied on his clear and forcible style of address to remove the difficulties in his way, and that himself, holding his views to be true and useful, he slighted the uneasiness or alarm which it creates in the minds of many, but there are numbers to whom it will appear very questionable whether he would not better have fulfilled his official duty by offering instruction respecting the established principles and interesting facts of natural science, rather than speculative views on the most recondite question his science afforded.

It would be useless, however, to press this objection now, and although there are undoubtedly fitnesses of things, in respect to times and places for propounding opinions, the mischief which it is possible to do by their violation is temporary and transient whilst we may rely on the great general law that, whatever may appear at the moment or to the partial view of individuals, discussion must ultimately promote the cause of truth.

Another preliminary observation is, we think, called for before we endeavour to estimate the force of Prof. Huxley's argument. He has more than once insisted on the origin of species being an inquiry essential to their scientific study, and there being before the public no hypothesis on the subject, entitled to the least attention, except the Darwinian, and he takes this to be a presumption in its favour, entitling it, at least for the present, to guide the course of inquiry on the subject. Now it appears to us that the preliminary inquiry is, whether there exist in nature any forms of fixed character, varying only within certain limits, and through an indefinite succession of generations remaining continually the same; or whether organic structures are subject to gradual modification, so as after a certain succession of generations to be found very materially different from their original condition, and to be accounted different species. If our inquiries lead us to the former conclusion, every species in nature has come into existence at some time and place, and it is an important inquiry how long each can be proved by good evidence to have existed, and within what geographical limits it has been confined; but there is scarcely any place for inquiry respecting the act of creation since it is not easy to perceive how it could be effected by the operation of second causes, and if we can conceive of such causes they are out of the field of natural science, and if ever determined it must be by other means than the observation of nature and the study of the relations between differing structures. If, on the other hand, we conclude that such distinctions, as properly mark species, are liable to change with the progress of time, and can produce good evidence that even any one distinct species has been derived from any other in the course of ages, then it may be reasonable to admit the possibility of all varying forms having been derived from one primitive germ, and the manner in which such changes have been effected, the causes upon which they depend, become subjects of intense interest, and furnish the most important inquiries in which a naturalist can be engaged. But it seems to us most unreasonable, to expect that the believer in the immutability of species should want a theory as to their origin. He sees throughout nature the abundant evidence of the operation of an intelligent designing mind, the great first cause of all things. He sees every species adapted to its condition and enabled to supply its wants, and the conception of a creative act, as the expression of an almighty volition, is sufficient to account to him for the existing order of things—objects may have been created simultaneously or successively, ; all in one place on the earth's surface, or in various localities; but as long as they are acknowledged to be essentially distinct objects, and to have no natural tendency to intermix and modify each other, they admit of no inquiry into the nature of the modifying causes, and consequently of no theory of the formation of species. It is quite true that we recognise a common plan of structure in a variety of objects; on examination this plan is found to consist in a certain arrangement of elementary organs, which, in some form, are always present, whilst the characteristics of species seem to be really found in the tendencies to comparative development of certain parts, which, in all of the same genus tribe or sub-kingdom, are at least rudimentally present, bearing to each other certain common relations. The truest notion of a species may perhaps be that of a group of developmental tendencies, fixed in the nature of things and only liable to modification by external causes within certain limits. Since those differences of plan or degree of development which mark genera, tribes and sub-kingdoms are without doubt at least as constant as those which distinguish species, it follows that these larger groups are natural and real associations of objects as much as species themselves, and that in determining them we find out, and invent names to express, something existing, and it is a great mistake to represent classification as a mere human contrivance of which there may be many varieties equally well founded. A classification which may serve some purposes may be founded upon any observed resemblances and differences amongst objects; but a true natural classification is the interpretation of the great plan of the Creator, expressing real affinities amongst organised beings, and pointing out their natural relationships whether direct or analogical, that is, whether consisting in conformity to a common type, or in a correspondent position as to mode of development and plan of life in respect to different types.

The believers in the transmutation of species will naturally enough regard the case of different organisms, resembling each other in many important particulars, and approaching each other more or less nearly, as favouring their notion of a common origin of all organic structures, and as illustrating different stages of progress or the influence of different circumstances, but the facts are equally accounted for by admitting a certain plan of creation. They are in truth much better accounted for, since the regularity with which we may generally observe each type to display an equal number of analogous variations, affords proof of a great plan running throughout nature, and excludes the idea of the differences of species depending on such influences as incidental special development in one of the offspring of a creature, giving that one advantages in the struggle for existence which are transmitted to its descendants.

We deduce from these considerations that it is not the business of the philosophical inquirer to form some theory respecting the origin of the various species of organised beings, unless he has first observed in them such signs of fluctuation and of being modified by causes, of which he can estimate the operation, as to turn his thoughts in that direction. So long as species are regarded by him as fixed and constant forms, he is not as a naturalist concerned with their origin, but only with their mutual relations as parts of the great system of the universe.

Let us now turn to Mr. Huxley's mode of dealing with the subject before us, and we shall first quote a passage containing his statement of the principles upon which such inquiries as that proposed must be conducted (Lecture VI., p. 130, American edition.)

> "I stated to you in substance, if not in words, that wherever there are complex masses of phenomena to be inquired into, whether they be phenomena of the affairs of daily life, or whether they belong to the more abstruse and difficult problems laid before the philosopher, our course of proceeding in unravelling that complex chain of phenomena with a view to get at its cause, is always the same; in all cases we must invent a hypothesis; we must place before ourselves some more or less likely supposition respecting that cause; and then, having assumed a hypothesis, having supposed a cause for the phenomena in question, we must endeavour, on the one hand, to demonstrate our hypothesis, or, on the other, to upset and reject it altogether by testing it in three ways. We must, in the first place, be prepared to prove that the supposed causes of the phenomena exist in nature; that they are what the logicians call *veræ causæ*—true causes;—in the next place, we should be prepared to show that the assumed causes of the phenomena are competent to produce such phenomena as those which we wish to explain by them; and in the last place, we ought to be able to show that no other known causes are competent to produce these phenomena. If we can succeed in satisfying these three conditions, we shall have demonstrated our hypothesis; or rather I ought to say, we shall have proved it as far as certainty is possible for us; for, after all, there is no one of our surest convictions which may not be upset, or at any rate modified by a further accession of knowledge."

We make no objection to these principles, but, as already indicated, we consider it as requiring proof that the phenomena of species are such as demand any investigation of their cause, or easily admit the supposition of any second cause. We pass on to Professor Huxley's concise statement of the Darwinian hypothesis (Lect. VI., p. 131, Am. Ed.)

> "What is Mr. Darwin's hypothesis? As I apprehend it—for I have put it into a shape more convenient for common purposes than I could find *verbatim* in his book—as I apprehend it, I say, it is, that all the phenomena of organic nature, past and present, result from, or are caused by, the inter-action of those properties of organic matter, which we have called ATAVISM and VARIABILITY, with the CONDITIONS OF EXISTENCE; or in other words,—given the existence of organic matter, its tendency to transmit its properties, and its tendency occasionally to vary; and, lastly, given the conditions of existence by which organic matter is surrounded—that these put together are the causes of the Present and of the Past conditions of ORGANIC NATURE."

Accepting this as a clear and accurate summary, we shall find that the points requiring to be carefully examined are the proper meaning and natural limits of Atavism and Variability, and we must recollect that the existence of these tendencies is equally admitted by both parties. The question is whether, in connection with the external conditions of existence, they are fully sufficient to account for all the phenomena of species, genera and higher groups amongst organized bodies, or whether the modifications they produce are subservient to certain determinate inherent tendencies of development, descending from the first created organisms and constituting the great plan of creation which, as we learn to interpret it, we express by the kingdoms, sub-kingdoms, classes, tribes, genera, and species. Now this question is identical with that of the permanence or mutability of species, which is therefore, we apprehend, the real subject of controversy. Granting their mutability, we do not pretend to adduce more probable influences for their modification than those assigned by Mr. Darwin, and all who maintain their permanence believe the cases of variation brought forward to be confined to varieties and races, and to affect characters which are not essential to the species. It is easy to assume that the existence of certain structural resemblances implies a common origin, but such resemblances form an essential part of the notion of a plan of creation in which every position is occupied and in which the utmost variety is produced by special adaptations of various types. They are as well accounted for on the one scheme as on the other—unless indeed we recognise in the regularity of corresponding variations of different types, the impossibility of what may be termed accidental causes of variation, such as are supposed in Darwin's hypothesis, having any place.

It seems to us beyond all reasonable question that what is absolutely required before we can admit the possibility of the transmutation theory, is the production of at least one clear instance of descendants of a common parent, having by the joint action of variability and atavism become so distinct in structure as to be fairly accounted separate species. This we do not believe to have been done. We know, however, that the want of any definition of a species in which both parties can agree, and the power of requiring indefinite periods of time to accomplish the supposed changes, will prevent this test being of much value for convincing opponents. We must therefore be content with enquiring what we really know of atavism and variability, and what proof can be brought forward of the tendency of long periods of time, to change the characters of species.

Atavism is but a name for the general law that the offspring resemble the parents. The resemblance is not a complete and exact one, but it is real and certain, and we believe it to include all the particulars which characterise the species. There is a certain amount of variation arising partly from assignable, partly from unknown causes, the nature and extent of which is learned by experience. In cases of a sexual reproduction, whether naturally occurring by gemmation or fissure, or artificially produced by section with replacement of parts, the variation is almost nothing. In reproduction by the fertilised ovum a regular series of changes is passed through before reaching the complete condition of the organism, and this condition is not an exact copy in every particular of the parents, for they themselves differ in some points; there are variations in the influence of each parent upon the offspring; there are effects of such causes as temperature, food, atmospheric conditions, and superinduced habits on the development of the germ; and there are internal causes not to be estimated by us which, within seemingly narrow limits, affect development so as to produce slight deviations from a precise pattern. Again it is observed that existing varieties in parents are most commonly transmitted to the offspring, if found alike in both parents very generally; if only occurring in one parent, much less uniformly, yet the peculiarity frequently occurring. When by selective breeding a variety is kept up through successive generations, it becomes a permanent variety or race which may either have become insulated by its position or may be studiously kept up on account of its beauty or utility, but if the causes which maintain the variety are removed the offspring gradually return to the more normal specific types. The advocate of the Darwinian hypothesis believes that no real difference can be recognised between species and varieties; that there are no determinate inherent tendencies of development limiting the action of causes of variation, and that new species are produced, as some also become extinct, in the ordinary course of nature. We ask, has he proved by sufficient examples that varieties tend to recede more and more from the specific type and do not tend to return to it; that species are capable of mixing by the production of *fertile* intermediate forms which thus in reality become new species, or that palæontological facts encourage the idea, that species are transmuted, of course very gradually, through a lengthened period of time? The transmission through several generations of the monstrosity of a sixth finger, has no more to do with specific distinctions than the transmission of a particular cast of features, complexion, tendency to certain diseases or any similar instance of atavism acting in subservience to the more marked tendencies which constitute species. The history of the otter breed of sheep exemplifies the formation and preservation of races, but affords no argument for their breaking through the natural boundaries of species. The case of the varieties of pigeons is a very interesting one, and the more so because the leading varieties seem to exhibit the same tendencies of development which distinguish the larger really distinct groups and prevail throughout nature; but so long as it is generally agreed that all the varieties have sprung from *columba livia*, and it is reasonably supposed that if not under the care of man they would gradually fall back into that species, instances of partial return being frequent; and so long as the difficulty remains, which is candidly acknowledged by Prof. Huxley, respecting the general if not universal infertility of hybrids between species, we cannot admit that the phenomena of the races of domestic pigeons afford any evidence whatever against the natural and real separation of species. Races which are habitually under the care of man, being cherished and kept in favourable circumstances to suit his purpose, may well illustrate the extent to which variations may be carried, but are least of all to be alleged as examples of the formation of distinct types of structure, the very fact of the peculiarities occurring in such circumstances being a warning to us against attributing to them any specific importance.

We have such clear evidence of the antiquity of various existing species both of animals and plants, which plainly appear to be now what they were many centuries ago, that the presumption is against the influence of time in modifying organised structures. Direct evidence on the subject can only be derived from palaeontological studies, and the defenders of the Darwinian hypothesis have been forward to claim the facts of the palæontology as favouring their views. The following passage from Mr. Huxley shows how they proceed: (Lect. VI., p. 136—140, Am. Ed.)

"If you regard the whole series of stratified rocks—that enormous thickness of sixty or seventy thousand feet that I have mentioned before, constituting the only record we have of a most prodigious lapse of time, that time being, in all probability, but a fraction of that of which we have no record;—if you observe in these successive strata of rocks successive groups of animals arising and dying out, a constant succession, giving you the same kind of impression, as you travel from one group of strata to another, as you would have in travelling from one country to another;—when you find this constant succession of forms, their traces obliterated except to the man of science,—when you look at this wonderful history, and ask what it means, it is only a paltering with words if you are offered the reply,—"They were so created."

But if, on the other hand, you look on all forms of organized beings as the results of the gradual modification of a primitive type, the facts receive a meaning, and you see that these older conditions are the necessary predecessors of the present. Viewed in this light the facts of palæontology receive a meaning—upon any other hypothesis, I am unable to see, in the slightest degree, what knowledge or signification we are to draw out of them. Again, note as bearing upon the same point, the singular likeness which obtains between the successive Faunæ and Floræ, whose remains are preserved on the rocks: you never find any great and enormous difference between the immediately successive Faunæ and Floræ, unless you have reason to believe there has also been a great lapse of time or a great change of conditions. The animals, for instance, of the newest tertiary rocks, in any part of the world, are always, and without exception, found to be closely allied with those which now live in that part of the world. For example, in Europe, Asia, and Africa, the large mammals are at present rhinoceroses, hippopotamuses, elephants, lions, tigers, oxen, horses, &c.; and if you examine the newest tertiary deposits, which contain the animals and plants which immediately preceded those which now exist in the same country, you do not find gigantic specimens of ant-eaters and kangaroos, but you find rhinoceroses, elephants, lions, tigers, &c.,—of different species to those now living,—but still their close allies. If you turn to South America, where, at the present day, we have great sloths and armadilloes and creatures of that kind, what do you find in the newest tertiaries? You find the great sloth-like creature, the *Megatherium*, and the great armadillo, the *Glyptodon*, and so on. And if you go to Australia you find the same law holds good, namely, that that condition of organic nature which has preceded the one which now exists, presents differences perhaps of species, and of genera, but that the great types of organic structure are the same as those which now flourish.

What meaning has this fact upon any other hypothesis or supposition than one of successive modification? But if the population of the world, in any age, is the result of the gradual modification of the forms which peopled it in the preceding age,—if that has been the case, it is intelligible enough; because we may expect that the creature that results from the modification of an elephantine mammal shall be something like an elephant, and the creature which is produced by the modification of an armadillo-like mammal shall be like an armadillo. Upon that supposition, I say, the facts are intelligible; upon any other, that I am aware of, they are not.

So far, the facts of palæontology are consistent with almost any form of the doctrine of progressive modification; they would not be absolutely inconsistent with the wild speculations of De Maillet, or with the less objectionable hypothesis of Lamarck. But Mr. Darwin's views have one peculiar merit; and that is, that they are perfectly consistent with an array of facts which are utterly inconsistent with and fatal to, any other hypothesis of progressive modification, which has yet been advanced. It is one remarkable peculiarity of Mr. Darwin's hypothesis that it involves no necessary progression or incessant modification, and that it is perfectly consistent with the persistence for any length of time of a given primitive stock, contemporaneously with its modifications. To return to the case of the domestic breeds of pigeons, for example; you have the Dovecot pigeon, which closely resembles the Rock pigeon, from which they all started, existing at the same time with the others. And if species are developed in the same way in nature, a primitive stock and its modifications may, occasionally, all find the conditions fitted for their existence; and though they come into competition, to a certain extent, with one another, the derivative species may not necessarily extirpate the primitive one, or *vice versâ.*

Now palæontology shows us many facts which are perfectly harmonious with these observed effects of the process by which Mr. Darwin supposes species to have originated, but which appear to me to be totally inconsistent with any other hypothesis which has been proposed. There are some groups of animals and plants, in the fossil world, which have been said to belong to "persistent types," because they have persisted, with very little change indeed, through a very great range of time, while everything about them has changed largely. There are families of fishes whose type of construction has persisted all the way from the carboniferous rock right up to the cretaceous; and others which have lasted through almost the whole range of the secondary rocks, and from the lias to the older tertiaries. It is something stupendous this—to consider a genus lasting without essential modifications through all this enormous lapse of time while almost everything else was changed and modified."

Mr. Huxley calls it paltering with words to say of the succession of organisms revealed by an examination of the earth's strata, that they were so created, meaning that this is all we know of their origin. We confess to a different feeling. There may be a grand scheme of successive creations, suited to changes, taking place in the physical condition of the globe, as well as a scheme of successive changes in mode and degree of development of organs derived from the primitive living element Which of these schemes is most conformable to known facts must be determined by observation, but if the origin of life be at all referred to a direct exertion of the will of a supreme intelligence, we cannot see that the former scheme is less antecedently probable than the latter; and even if it be referred to the operation of chemical laws, laws of nature do not imply any powers inherent in matter, but are only our expressions of the observed uniformity of a class of results from causes—and really only direct our attention to the mode of operation of the great first cause of all things. Mr. Huxley thus describes an objection to Darwin's hypothesis which we think he hardly treats fairly: "Well, after all," he supposes the objector to say, "you see Mr. Darwin's explanation of the 'origin of species' is not good for much, because, in the long run, he admits that he does not know how organic matter began to exist. But if you admit any special creation for the first particle of organic matter, you may just as well admit it for all the rest; five hundred or five thousand distinct creations are just as intelligible, and just as little difficult to understand, as one." Now, if such an objection were ever used as an argument against learning as much as we can of the order of Nature and mutual derivation of organized beings, it is as little worth as Mr. Huxley represents it; but if, as we apprehend, it was only meant to show that the Darwinian hypothesis relieves us from no fancied difficulty about the idea of creation, and that there is in truth no rational presumption in favour of the creation only of the first and simplest organisms, rather than the creation of numerous forms of living beings, and as often as a wise regard to other changes might require, then we must think the objection a sound one leaving us open to draw whatever truths we can from the study of nature, but convincing us that we are not driven to seek an origin of species in second causes, and that there is no strong reasonable presumption that such might be found.

We cannot at all perceive why, the prevalence of certain sections of the animal kingdom in particular regions of the globe being an admitted fact in respect to the present state of things, it should not be admitted as equally suitable in any former state—or why the present existence of the armadillo where an armadillo-like animal formerly existed should be admitted as any proof that the one is descended from the other without distinct evidence of gradual changes. But perhaps the best thing we can do with this palæontological argument will be to bring under the reader's notice, in immediate connection with Prof. Huxley's reasoning, the sentiments on the same subject of one of the greatest living authorities, and who cannot possibly, from his known opinions on the subject, be supposed to be prejudiced in favour of old-fashioned doctrines. We shall quote from a note to the second chapter of the first part of Agassiz's treatise on the Acalephae in his contributions to the Natural History of the United Sates, (Vol. III., p. 90, Note 1,) the sentiments of this eminent palæontologist respecting Darwin's geological arguments.

*"It seems generally admitted, that the work of Darwin is particularly remarkable for the fairness with which he presents the facts adverse to his views. It

may be so; but I confess that it has made a very different impression upon me. I have been more forcibly struck with his inability to perceive when the facts are fatal to his argument, than with anything else in the whole work. His chapter on the Geological Record, in particular, appears to me to be, from beginning to end, a series of illogical deductions and misrepresentations of the modern results of Geology and Palæontology. I do not intend to argue here, one by one, the questions he has discussed. Such arguments end too often in special pleading; and any one familiar with the subject may readily perceive where the truth lies, by confronting his assertions with the geological record itself. But, since the question at issue is chiefly to be settled by palæontological evidence, and I have devoted the greater part of my life to the special study of the fossils, I wish to record my protest against his mode of treating this part of the subject. Not only does Darwin never perceive when the facts are fatal to his views, but, when he has succeeded by an ingenious circumlocution in overleaping the facts, he would have us believe that he has lessened their importance, or changed their meaning. He would thus have us believe that there have been periods during which all that had taken place during other periods were destroyed; and this solely to explain the absence of intermediate forms between the fossils found in successive deposits, for the origin of which he looks to those missing links, whilst every recent progress in Geology shows more and more fully how gradual and successive all the deposits have been which form the crust of our earth.—He would have us believe that entire faunæ have disappeared before those were preserved, the remains of which are found in the lowest fossiliferous strata; when we find everywhere non-fossiliferous strata below those that contain the oldest fossils now known. It is true, he explains their absence by the supposition that they were too delicate to be preserved; but any animals from which Crinoids, Brachiopods, Cephalopods, and Trilobites could arise, must have been similar enough to them to have left, at least, traces of their presence in the lowest non-fossiliferous rocks, had they ever existed at all.—He would have us believe that the oldest organisms that existed were simple cells, or something like the lowest living beings now in existence: when such highly organized animals as Trilobites and Orthoceratites are amongst the oldest known.—He would have us believe that these lowest first-born became extinct, in consequence of the gradual advantage some of their more favored descendants gained over the majority of their predecessors; when there exist now, and have existed at all periods in past times, as large a proportion of more simply organized beings, as of more favored types; and when such types as Lingula were among the lowest Silurian fossils, and are alive at the present day.—He would have us believe that each new species originated in consequence of some slight change in those that preceded; when every geological formation teems with types that did not exist before.—He would have us believe that animals and plants became gradually more and more numerous; when most species appear in myriads of individuals, in the first bed in which they are found.—He would have us believe that animals disappear gradually; when they are as common in the uppermost bed in which they occur, as in the lowest, or any intermediate bed. Species appear suddenly and disappear suddenly in successive strata. That is the fact proclaimed by Palæontology;

they neither increase successively in number, nor do they gradually dwindle down; none of the fossil remains thus far observed show signs of a gradual improvement or of a slow decay.—He would have us believe that geological deposits took place during periods of subsidence; when it can be proved that the whole continent of North America is formed of beds which were deposited during a series of successive upheavals. I quote North America in preference to any other part of the world, because the evidence is so complete here that it can be overlooked only by those who may mistake subsidence for the general shrinking of the earth's surface, in consequence of the cooling of its mass. In this part of the globe, fossils are as common along the successive shores of the rising deposits of the Silurian system, as anywhere along our beaches: and each of these successive shores extends from the Atlantic States to the foot of the Rocky Mountains. The evidence goes even further; each of these successive sets of beds of the Silurian system contains peculiar fossils, neither found in the beds above nor in the beds below, and between them there are no intermediate forms. And yet Darwin affirms that "the littoral and sub-littoral deposits are continually worn away, as soon as they are brought up by the slow and gradual rising of the land within the grinding action of the coast waves."—(Origin of Species, p. 290.)—He would also have us believe that the most perfect organs of the body of animals are the product of gradual improvement; when eyes as perfect as those of the Trilobites are preserved with the remains of these oldest animals.—He would have us believe that it required millions of years to effect any one of these changes; when far more extraordinary transformations are daily going on, under our eyes, in the shortest periods of time, during the growth of animals.—He would have us believe that animals acquire their instincts gradually; when even those that never see their parents, perform at birth the same acts, in the same way, as their progenitors.—He would have us believe that the geographical distribution of animals is the result of accidental transfers; when most species are so narrowly confined within the limits of their natural range, that even slight changes in their external relations may cause their death. And all these, and many other calls upon our credulity, are coolly made in the face of an amount of precise information, readily accessible, which would overwhelm any one who does not place his opinions above the records of an age eminently characterized for its industry; and during which, that information was laboriously accumulated by crowds of faithful laborers.

Professor Huxley argues from the existence of rudimentary organs, such as "the splint-like bones in the leg of the horse, which correspond with bones which belong to certain toes and fingers in the human hand and foot;" the rudimentary cutting teeth on the upper jaw of the young calf; the teeth of the foetal whale which are never used and come to nothing, and other similar instances; contending that such facts are entirely unaccountable and inexplicable except on Mr. Darwin's hypothesis, according to which the whalebone whale descended from a whale with teeth, the horse from an animal with several toes, the ruminant from an animal furnished with cutting teeth in its upper jaw. We have already referred to this subject, and we need only say now that the facts can be generalised in at least two distinct ways, the one followed by Darwin, in which imperfectly developed organs are regarded as indicating their partial suppressions by accidental variety, and the view previously taken that in forming a perfect creation in which every position should be suitably filled, and the greatest possible amount of life and enjoyment be produced; the almighty and all-wise intelligence used a plan, according to which the required variety depended not on so many altogether different types of structure, but on changes in the comparative development of parts in structures belonging to one type, the common relationship giving unity to the whole, and harmonising the various parts into one grand system. According to this view certain elements of structure belonging to one organic type would receive their fullest development in one form, and in others would be gradually reduced until they existed only imperfectly or rudimentally, so as in many instances not to be observable without investigation or only to become observable under peculiar circumstances. We account the latter view the most antecedently probable because it best explains the analogies as well as affinities observable in nature; because it is most consistent with the uniformity and completeness of the design which seems to us to pervade creation, and is more readily conceived as the result of ordinary intelligence. But it would be enough, as an answer to Prof. Huxley's argument, merely to shew that there is a way of viewing the occurrence of imperfectly developed organs, which is reasonable and consistent in itself, and by no means requires or favours the Darwinian hypothesis.

On the whole, it must be acknowledged that the cases of the phenomena exhibited by species, suggested by Darwin, have a real existence in Nature. Proceeding to the second test, we deny that they are, so far as we yet know, competent to give rise to all the phenomena; since, besides the admitted difficulty about sterility of hybrids, it has not been proved that the tendency to variation ever passes the boundaries imposed by predominating developmental tendencies which constitute species, and it is not proved that any degrees of variation entitled to be called specific have arisen within our knowledge, or that time, however long the period attained, tends to increase the extent of variation. We cannot affirm that the contradictory of these propositions is absolutely proved, but it seems to us in each case to be more probable. As to the third test, the hypothesis being the only one which can explain the phenomena, we cannot understand upon what ground Prof. Huxley believes that "the alternative is Darwinian or nothing." The opponents of the new hypothesis may not profess to explain the origin of species by tracing them to second causes, but they insist that they are not called upon to do so. They find, as they think, organised nature made up of permanently distinct structures, amidst their differences bearing numerous and striking relations to each other, and together forming a connected whole displaying one grand plan, and presenting an inconceivable variety of different combinations of organs, all working out, by varying means, a common end and together filling creation with order, harmony, beauty, forming one grand and beneficent system.

If it were a legitimate aim of philosophy to prevent the thought of Deity from arising from the contemplation of his works, we should have made a step in advance in adopting Darwin's hypothesis which makes all the variety in nature the result of fixed physical laws, and limits the direct operation of the Divine volition to the production of the first organised element. Even so however a creative act is required, and if for one creature why not for a million? If for one condition of external nature, why not for any number of such conditions which may succeed one another on the earth's surface? The scheme of a creation of numerous species which may reproduce themselves with a certain limited variation is not essentially unphilosophical, and so long as we believe in the real distinctness of species is the most probable explanation of what we see. If the transmutation of species can be definitely established the case will be altered, and we may apply ourselves with advantage to the study of the law of modification. Our limited space forbids, at present, the fuller expression of our views on this interesting subject, but differing as we do from Messrs. Darwin and Huxley and other eminent naturalists, we readily receive the speculations which have engaged their minds as worthy of candid consideration, and only desire that they may be so considered as to promote sound knowledge, just views, and practical utility.

W. H.

MONTHLY METEOROLOGICAL REGISTER, AT THE PROVINCIAL MAGNETICAL OBSERVATORY, TORONTO, CANADA WEST,—JUNE, 1868.

Latitude—43 deg. 39.4 *min. North. Longitude—*5 *h.* 17 *m.* 33 *s. West. Elevation above Lake Ontario,* 108 *feet.*

Day.	Barom. at temp. of 32°.				Temp. of the Air.				Excess of mean above Normal.	Tens. of Vapour.				Humidity of Air.				Direction of Wind.			Resul't. Direction.	Velocity of Wind.					Rain in inches.	Snow in inches.
	6 A.M.	2 P.M.	10 P.M.	Mean.	6 A.M	2 P.M	10PM	ME'N		6 A.M	2 P.M.	10 P.M.	M'N	6 A.M	2 P.M.	10 P.M.	M'N	6 A. M.	2 P. M.	10 P. M.		6 AM.	2 PM.	10 P.M.	Re-sul't.	ME'N		
1	28.982	29.038	29.101	29.0492	°58.0	°61.2	°50.8	°57.08	+ °0.13	.428	.264	.284	.326	.89	.47	.76	.69	s w	w b N	w s w	s °78 w	5.3	24.0	6.8	13.78	14.11	0.065	...
2	29.183	.311	.458	.3343	51.1	57.3	50.8	52.85	— 4.42	.290	.336	.272	.290	.76	.71	.73	.72	w b s	w N w	N w b N	N 77 w	11.0	15.2	8.8	10.56	11.05	Inp.	...
3	.547	.556	.568	.5577	47.2	55.8	47.9	50.95	— 6.60	.258	.280	.259	.267	.79	.62	.77	.72	N N w	s b w	Calm.	N 49 w	5.5	6.7	0.0	1.89	3.45	...	...
4	.614	.541	.534	.5577	45.0	61.2	52.6	53.47	— 4.38	.239	.340	.300	.303	.80	.63	.75	.74	Calm.	s b E	s w	s 16 w	0.0	9.0	2.5	2.67	2.96	0.125	...
5	.532	.554	.658	.5913	52.2	57.2	49.3	52.55	— 3.60	.315	.337	.313	.325	.80	.71	.89	.82	N	s b E	N w b N	N 26 w	0.5	2.2	0.5	2.30	3.29	0.625	...
6	.718	.753	.800	.7678	48.6	58.0	46.8	51.42	— 7.03	.292	.217	.216	.240	.85	.44	.67	.64	N w	N N w	N N w	N 23 w	10.0	11.6	7.0	10.22	10.28	...	...
7	.817	.760	—	—	46.8	59.8	—	—	—	.245	.247	—	—	.76	.47	—	—	N	N b E	N w b N	N 30 w	10.3	13.4	11.0	12.13	12.23	Inp.	...
8	.710	.669	.645	.6638	51.8	65.5	58.0	58.45	— 0.62	.310	.316	.326	.305	.80	.50	.67	.63	N N w	N w b N	N w	N 30 w	9.6	14.8	8.5	10.90	11.25	Inp.	...
9	.592	.549	.556	.5678	56.9	74.9	61.6	65.38	+ 5.90	.244	.230	.290	.255	.53	.26	.53	.42	N w b N	N w b N	N w b N	N 36 w	15.5	19.5	6.5	12.64	12.68	...	...
10	.564	.540	.494	.5295	57.6	75.3	60.5	64.52	+ 4.73	.299	.337	.349	.333	.62	.38	.66	.56	N w	s w b s	s w b s	s 36 w	0.5	11.0	0.5	3.44	3.69	...	...
11	.506	.480	.526	.5063	56.2	63.7	58.7	59.28	— 0.70	.360	.401	.396	.393	.80	.68	.80	.78	s	Calm.	Calm.	N 47 w	0.2	0.0	0.0	0.54	1.31	0.075	...
12	.548	.584	.646	.5970	60.5	63.0	62.7	62.48	+ 2.22	.418	.487	.441	.451	.79	.84	.77	.80	N b w	N w b w	N w	N 28 w	1.5	10.8	3.5	6.62	7.33	0.077	...
13	.667	.705	.737	.7092	62.7	71.7	63.0	66.80	+ 6.22	.402	.531	.450	.467	.70	.68	.78	.71	N b E	s s w	Calm.	s 14 w	7.5	2.5	0.0	0.78	1.69	...	...
14	.722	.669	—	—	61.2	77.5	—	—	—	.422	.539	—	—	.78	.57	—	—	Calm.	s s w	s w b w	s 64 w	0.0	5.0	2.0	3.45	3.99	...	...
15	.502	.518	.681	.5767	70.6	79.3	60.5	69.47	+ 8.33	.452	.336	.372	.382	.60	.33	.70	.55	w N w	N N w	N	N 27 w	13.4	17.0	9.5	10 94	11.54	...	...
16	.806	.739	.584	.7015	53.3	61.2	50.8	56.00	— 5.35	.217	.250	.241	.243	.53	.46	.64	.54	N E b N	s b w	Calm.	s 6 E	6.0	2.5	0.0	1.09	2.52	...	..
17	.369	.314	.333	.3300	55.4	60.5	50.8	55.87	— 5.78	.371	.294	.313	.320	.85	.55	.84	.72	E N E	E b s	Calm.	N 78 E	2.5	9.0	0.0	1.90	2.24	...	...
18	.326	.370	.305	.3212	53.3	70.2	58.3	62.00	+ 0.05	.332	.368	.368	.369	.82	.49	.75	.67	N w b N	s b w	Calm.	s 22 w	1.5	2.5	0.0	0.80	1.71	...	...
19	.315	.348	.424	.3653	55.1	68.4	59.8	62.12	— 0.02	.364	.468	.417	.432	.84	.67	.81	.78	s s w	s s E	N	s 58 E	0.8	1.8	1.5	1.25	1.84	...	...
20	.439	.432	.454	.4433	54.7	63.7	53.3	56.58	— 5.87	.370	.452	.377	.399	.86	.76	.92	.87	N E b E	s E	Calm.	N 79 E	1.0	4 5	0.0	1.73	2.56	0.475	...
21	.497	.499	—	—	51.8	59.0	—	—	—	.363	.439	—	—	.94	.88	—	—	Calm.	s w b s	s w b s	s 25 w	0.0	7.0	1.5	2.26	2.53	0.030	...
22	.473	.439	.516	.4827	51.0	60.9	53.6	56.42	— 6.53	.367	.414	.362	.382	.88	.78	.87	.84	Calm.	s w b s	w s w	s 60 w	0.0	11.4	2.8	3.09	4.39	0.185	...
23	.599	.661	.729	.6708	52.2	62.7	57.2	57.73	— 5.42	.337	.366	.405	.365	.86	.64	.86	.77	w N w	w N w	N N w	N 61 w	1.0	10.5	7.8	6.18	6.36	...	...
24	.795	.788	.785	.7867	53.6	62.3	53.3	57.73	— 5.62	.351	.410	.344	.370	.85	.73	.84	.78	N w	s	Calm.	s 14 w	4.8	2.8	0.0	0.80	1.71	...	...
25	.823	.776	.754	.7835	55.8	69.9	56.9	61.53	— 2.02	.365	.371	.396	.372	.82	.49	.85	.70	Calm.	s s E	Calm.	s 88 E	0.0	5.0	0.0	1.19	2.38	...	...
26	.759	.732	.723	.7387	59.8	71.0	62.3	65.32	+ 1.43	.381	.485	.471	.432	.74	.64	.84	.70	N N E	s E b E	N E b E	s 88 E	0.5	4.8	2.6	2.90	3.07	...	...
27	.773	.755	.677	.7283	62.3	71.3	62.3	65.30	+ 1.23	.497	.523	.459	495	.88	.68	.82	.80	Calm.	E s E	Calm.	s 74 E	0.0	4.4	0.0	2.67	2.74	...	...
28	.662	.630	—	—	66.6	74.2	—	—	—	.531	.511	—	—	.82	.60	—	—	E s E	E s E	Calm.	s 75 E	2.5	10.0	0.0	3.91	4.08	...	...
29	.567	.515	.477	.5110	66.6	73.5	70.2	70.23	+ 5.78	.479	.550	.565	.534	.73	.66	.76	.72	E b s	E b N	s E b s	s 81 E	4.5	10.5	4 8	5.42	5.89	Inp.	...
30	.480	.498	.498	.4900	68.4	75.7	68.4	71.80	+ 7.22	.596	.752	.604	.653	.86	.84	.87	.83	E	s w b s	E N E	s 24 E	1.0	6.2	0.5	1.76	2.43	0.005	...
31	......	......	......	......	......	......	......	......	....	......	......	......	......	...	...		...	....	....	....	....	......	......	......	......	......	......	...
M	29.5457	29.5448	29.5640	29.5523	56.27	65.98	56.94	60.13	— 0.90	.359	.389	.369	.373	.78	.60	.77	.71	....	....	....	....	3.77	8.25	2.86	......	5.24	1.662	......

REMARKS ON TORONTO METEOROLOGICAL REGISTER FOR JUNE, 1863.

Highest Barometer . . . . 29.844 at 8 a.m. on 16th. } Monthly range=
Lowest Barometer . . . . 28.982 at 6 a.m. on 1st. } 0.862 inches.

Self-registering Ther.
Maximum temperature . . . . 84°8 on p.m. of 15th } Monthly range=
Minimum temperature . . . . 37°4 on a.m. of 4th } 47°4
Mean maximum temperature . . . 69°23 } Mean daily range=17°24
Mean minimum temperature . . . 51°99 }
Greatest daily range . . . . 27°2 from a. m. to p. m. of 10th.
Least daily range . . . . 9°5 from a. m. to p. m. of 1st.

Warmest day . . . 30th...Mean Temperature . . . 71°80 } Difference=20°85.
Coldest day . . . . . 3rd ...Mean Temperature . . . 50°95 }
Maximum Radiation { Solar . . . . 96°4 on p.m of 15th } Monthly range=
Maximum Radiation { Terrestrial . . . . 29°2 on a. m. of 4th } 67°.2

Aurora observed on 4 nights, viz., 9th, 10th, 13th, 22nd. Possible to see Aurora on 19 nights; impossible on 11 nights.

Raining on 13 days; depth, 1 662 inches; duration of fall, 26.9 hours.

Mean of cloudiness=0.54; above average, 0.01. Most cloudy hour observed, 2 p.m; mean=0.70; least cloudy hour observed, midnight; mean=0.34.

Sums of the components of the Atmospheric Current, expressed in Miles.

North.	South.	East.	West.
1745.46	704.54	567.42	1814.65

Resultant direction, N. 50° W.; Resultant Velocity, 2.26 miles per hour.
Mean velocity 5.24 miles per hour.
Maximum velocity 25.8 miles, from 1 to 2 p.m. on 1st.
Most windy day 1st—Mean velocity 14.11 miles per hour. } Difference 12.80
Least windy day 11th—Mean velocity 1.31 miles per hour. }
Most windy hour, 1 to 2 p.m.—Mean velocity, 9.23 miles per hour. } Difference
Least windy hour, 9 to 10 p.m.—Mean velocity, 2.70 miles per hour. } 6.53 miles.

4th. Slight hoar frost at 5 a.m.; thunderstorm and heavy rain 2.50 to 3.30 p.m.; faint auroral light at 9.15 p.m.—9th. Brilliant aurora 10 p.m. to 1 a.m. of 10th, exhibiting arches, patches, pulsations, and streamers, and forming a corona at 1 a.m. about 10° S.S.W. of Zenith.—10th. Faint aurora at 10 p.m. and midnight.—11th. Distant thunder in West during the forenoon; fire flies numerous at night.—12th. Fire flies numerous at 10 p.m.; sheet lightning at midnight.—13th. Faint auroral light at midnight.—14th. Sheet lightning in West at 10 p.m.—20th. Thunderstorm, lightning, and rain, 7.40 to 8.15 a.m., and again from 4 to 8 p.m.—22nd. Thunderstorm 1.30 to 3.20 p.m.; auroral arch and streamers, 10 to 10.30 p m.—30th. Sheet lightning in W. and S.W. at 9 p.m.

**A considerable quantity of Pollen fell with the rain during the thunderstorm on 4th.
Heavy Dew recored on 11 mornings during this month.**

June, 1863, was comparatively cold, calm, cloudy, and very dry.

COMPARATIVE TABLE FOR JUNE.

YEAR.	TEMPERATURE.					RAIN.		SNOW.		WIND.		
	Mean.	Excess above Average, (61°4).	Maximum observed.	Minimum observed.	Range.	No. of days.	Inches.	No. of days.	Inches.	Resultant. Direction.	Resultant. Velocity.	Mean Force or Velocity
1840	59.8	— 1.6	78.5	37.1	41.4	11	4.860	...	...	...	...	...
1841	65.6	+ 4.2	92 8	45.7	47.1	9	1.560	...	...	...	...	0.36 lbs
1842	55.6	— 5.8	73.9	28.0	45.9	15	5.755	...	...	...	...	0.31 "
1843	58.4	— 3.0	81.3	28.5	52.8	12	4.595	...	...	...	...	0.27 "
1844	59.9	— 1.5	82.8	33.1	49.7	9	3.535	...	...	...	...	0.19 "
1845	61.0	— 0.4	83.6	40.9	42.7	11	3.715	...	...	...	...	0.27 "
1846	63.3	+ 1.9	83.3	41.5	41.8	10	1.920	...	...	...	...	0.32 "
1847	58.4	— 3.0	78.3	36.7	41.6	14	2.625	...	...	...	...	0.30 "
1848	62.9	+ 1.5	92.5	38.3	54.2	8	1.810	...	...	N 61 W	1.90	4.51 ms
1849	63.2	+ 1.8	84.9	45.2	39.7	7	2.020	...	...	S 71 E	0.49	3.32 "
1850	64.3	+ 2.9	83.2	49.0	34.2	10	3.345	...	...	S 60 W	0.38	4.54 "
1851	59.2	— 2.2	79.2	41.2	38.0	11	2.695	...	...	S 2 W	1.26	4.42 "
1852	60.8	— 0.6	86.1	43.6	42.5	10	3 160	...	...	S 76 W	1.49	4.09 "
1853	65.5	+ 4.1	86.3	43.3	43.0	9	1.550	...	...	N 1 W	0.10	3.73 "
1854	64 1	+ 2.7	88.7	47.4	41.3	9	1.460	...	...	N 24 E	0.71	4 15 "
1855	59.9	— 1.5	90.7	40.6	50.1	17	4.070	...	...	N 69 W	1.33	5.70 "
1856	62.1	+ 0.7	82.6	48.3	34.3	13	3.200	...	...	S 21 W	0.90	5.30 "
1857	56.9	— 4.5	75.1	40.9	34.2	21	5.060	...	...	N 49 W	1.15	7.60 "
1858	66.2	+ 4.8	86.3	48.7	37.6	12	2.943	...	...	S 20 E	0.25	5.53 "
1859	58.3	— 3.1	85.2	33.9	51.3	16	4.085	2	Inp.	N 77 W	1.95	7.19 "
1860	63.2	+ 1.8	81.1	50.0	31.1	14	2.136	...	...	N 44 W	3.13	7.61 "
1861	61.3	— 0.1	86.5	48.2	38.3	13	2.329	...	...	N 39 W	2.29	6.11 "
1862	60.5	— 0.9	83.2	44.3	38.9	10	1.007	...	...	N 26 W	1.77	5.98 "
1863	60.1	— 1.3	79.3	45.0	34.3	13	1.662	...	...	N 50 W	2.26	5.24 "
Results to 1861.	61.36	...	83.77	41.37	42.40	11.9	3.100	...	...	N 69 W	0.81	5.27
Exc. for 1863.	—1.23	...	— 4.47	+ 3.63	— 8.10	+ 1.1	— 1.438	...	...	...	...	—0.03

MONTHLY METEOROLOGICAL REGISTER, AT THE PROVINCIAL MAGNETICAL OBSERVATORY, TORONTO, CANADA WEST.—JULY, 1863.

Latitude—43 deg. 39.4 min. North. Longitude—5 h. 17 min. 33 sec. West. Elevation above Lake Ontario, 108 feet.

Day.	Barom. at temp. of 32°.				Temp. of the Air.				Excess of mean above Normal.	Tens. of Vapour.				Humidity of Air.				Direction of Wind.			Resultant Direction.	Velocity of Wind.					Rain in Inches.	Snow in Inches.
	6 A.M.	2 P.M.	10 P.M.	MEAN.	6 A.M.	2 P.M.	10 P.M.	ME'N		6 A.M.	2 P.M.	10 P.M.	M'N	6 A.M.	2 P.M.	10 P.M.	M'N	6 A.M.	2 P.M.	10 P.M.		6 A.M.	2 P.M.	10 P.M.	Re-sul't.	ME'N		
					°	°	°	°	°												°							
1	29.555	29.581	29.599	29.5757	71.7	82.1	70.2	75.12	+10.35	.661	.782	.580	.672	.86	.71	.78	.77	Calm.	S S E	N E	S 19 E	0.0	5.8	2.5	0.11	2.92	0.275	..
2	.610	.629	.619	.6220	68.1	75.3	69.5	71.27	+ 6.27	.637	.723	.661	.667	.93	.83	.92	.88	S b W	E b N	N	N 80 E	2.5	4.5	2.0	2.17	2.56	.005	...
3	.699	.695	.667	.6858	63.1	77.8	69.9	71.73	+ 6.58	.650	.723	.642	.661	.95	.75	.88	.85	Calm.	S E b S	S S E	S 67 E	0.0	2.2	0 5	0.93	1.43	...	...
4	.671	.620	.607	.6285	68.1	78.2	69.9	72.17	+ 6.87	.637	.685	.612	.648	.93	.71	.84	.82	Calm.	S b W	N	S 48 W	0.0	9.4	4.5	1.47	4.15	...	...
5	.601	.561	—	—	67.0	77.8	—	—	—	.556	.629	—	—	.86	.66	—	—	N N W	S	N b E	N 32 E	1.5	5.0	3.5	0.90	3.79	...	. .
6	.565	.566	.554	.5645	67.3	75.7	70.6	71.80	+ 6.20	.562	.623	.589	.594	.84	.70	.79	.76	N	E b S	N E b E	N 83 E	9.5	9.0	1.8	3.01	3.62	...	..
7	.593	.552	.536	.5557	69.9	76.0	70.6	73.12	+ 7.42	.584	.664	.632	.629	.79	.74	.84	.77	N N E	E b S	Calm.	S 68 E	0.5	1.8	0.0	1.49	2.02	.290	...
8	.509	.438	.441	.4582	68.1	79.6	76.4	73.67	+ 7.88	.622	.732	.555	.637	.91	.72	.60	.77	S W b W	S W b S	N b W	S 74 W	2.0	5.8	2.2	0.90	3.22	.075	...
9	.441	.420	.448	.4367	67.7	77.1	68.4	71.03	+ 5.10	.585	.685	.507	.596	.87	.73	.74	.79	N b W	S S E	Calm.	S 55 E	4.5	3.0	0.0	0.31	1.34	...	...
10	.462	.446	.450	.4470	66.6	77.5	67.0	70.78	+ 4.70	.599	.663	.608	.630	.91	.70	.92	.84	N b E	Calm.	Calm.	S 51 E	1.0	0.0	0.0	0.10	0.18	...	. .
11	.473	.464	.613	.5270	67.4	77.1	63.4	69.40	+ 3.22	.632	.685	.457	.591	.95	.73	.78	.82	Calm.	S W b S	N	N 33 W	0.0	9.5	14.2	4.86	7.80	Inp.	...
12	.769	.803	—	—	56.5	65.2	—	—	—	.368	.408	—	—	.80	.65	—	—	N N E	S E	S E b S	N 37 E	1.5	6.5	1.0	3.20	4.20	...	...
13	.633	.626	.534	.6217	60.5	64.8	61.6	62.05	— 4.33	.382	.503	.507	.468	.73	.81	.92	.83	N b E	E N E	N E	N 43 E	4.5	1.5	2.0	2.28	2.38	.645	...
14	.486	.471	.495	.4837	61.9	69.1	66.3	66.30	— 0.12	542	.608	.590	.580	.98	.86	.91	.90	N b W	S S W	S E b S	S 87 W	3.0	2.4	3.0	1.09	2.33	.010	...
15	.538	.551	.650	.584	63.0	74.6	60.1	66.73	+ 0.25	.450	.593	.425	.495	.78	.69	.81	.75	Calm.	S S E	W N W	S 79 W	0.0	9.0	7.6	2.89	6.48	.020	...
16	.722	.787	.867	.7975	53.3	62.7	52.9	56.55	—10.03	.344	.320	.306	.313	.84	.56	.76	.68	W N W	N N W	N N W	N 49 W	7.5	13.2	4.5	8.03	9.19	...	...
17	.890	.876	.871	.8807	49.3	64.1	54.4	56.52	—10.17	.260	.372	.308	.320	.74	.62	.73	.70	N	S b E	Calm.	N 89 E	5.5	5.5	0.0	1.07	2.87	...	...
18	.891	.865	.845	8678	54.7	68.1	55.9	61.0	— 5.63	358	.445	.341	.369	.84	.65	.73	.69	Calm	S by W	Calm.	S 40 E	0.0	5.8	0.0	1.01	3.43	...	...
19	.859	.819	—	—	56.9	69.5	—	—	—	.319	.325	—	—	.68	.45	—	—	N b E	S E	Calm.	S 48 E	2.2	5.0	0.0	1.50	1.85	...	...
20	.640	.502	.460	.5297	62.3	94.8	61.9	62.83	— 3.93	.497	.476	.503	.501	.88	.77	.90	.87	E b N	E b N	N E b E	N 50 E	2.8	10.5	6.0	8.20	9.72	1.665	...
21	.526	.594	.638	.5902	61.6	68.8	57.6	62.77	— 4.00	.428	.436	.342	.399	.78	.62	.72	.70	N	N W b N	N b W	N 18 W	16.0	13.0	4.4	10.22	10.39	..	...
22	.684	.668	.635	.6695	57.6	71.3	61.9	64.53	— 2.33	.353	.416	.401	.390	.74	.55	.72	.65	N W b N	S S W	S S W	S 23 W	3.8	7.5	1.8	2.71	3 13	...	...
23	.632	.628	.599	.6273	60.5	71.7	62.3	66.03	— 0.85	.434	.476	.522	.478	.82	.61	.93	.76	N N E	S E b S	Calm.	S 73 E	3.5	5.6	0.0	1.71	2.21	.008	...
24	.580	.607	.622	.6015	64.1	76.0	71.3	71.48	+ 4.62	.538	.639	.536	.581	.90	.71	.70	.70	Calm.	S S W	N N E	N 77 W	0.0	3.0	3.5	0.34	2.01	.015	...
25	.613	.498	.418	.4935	65.2	66.6	65.2	65.60	— 1.37	.510	.572	.536	.540	.82	.88	.87	.86	N N E	N E b E	N E b E	N 61 E	4.5	9.0	1.0	3.58	4.18	.345	...
26	.390	.395	—	—	64.1	74.9	—	—	—	.524	.713	—	—	.87	.83	—	—	N W b N	S	W	S 53 W	2.2	3.2	1.5	2.39	3.11	.030	...
27	.413	.465	.581	4908	63.2	73.5	60.5	66.52	— 0.47	.523	.375	.382	.424	.85	.45	.73	.67	W	W b S	N W b W	S 88 W	1.8	14.8	4.4	6.40	6.77	...	...
28	.639	.635	.657	.6403	58.3	74.6	64.8	66.75	— 0.22	.401	.563	.515	.502	.83	.65	.84	.77	Calm.	S S W	S W b S	S 10 W	0.0	10.8	1.5	3.93	4.51	...	...
29	.675	.602	.607	.6205	63.7	75.7	65.9	69.40	+ 2.45	.517	.548	.500	.535	.87	.62	.78	.75	N E	S E b S	Calm.	S 9 E	0.8	5.5	0.0	1.82	3.03	...	...
30	.578	.556	.555	.5590	64 1	70.8	65.9	67.62	+ 0.67	.512	.658	.595	.592	.85	.88	.93	.87	N N E	W S W	Calm.	S 59 E	0.5	1.5	0.0	0.66	0.91	.025	...
31	.570	.546	.499	.5413	66.6	76.0	70.6	71.55	+ 4.60	.572	.664	.616	.624	.88	.74	.83	.81	E b N	S S E	S S W	S 33 W	2.0	7.4	4.8	4.38	4.72	Inp.	...
M	29.6063	29.5884	29.5973	29.5963	63.51	72.95	65.04	67.57	+ 1.32	.511	.579	.510	.535	.85	.70	.81	.78	....	....	....	....	2.37	6.35	2.52	......	3.89	3 408	......

REMARKS ON TORONTO METEOROLOGICAL REGISTER FOR JULY, 1863.

Highest Barometer..............................29.912 at 8 a. m. on 18th } Monthly range =
Lowest Barometer ....29.390 at 6 a. m. on 26th } 0.522 inches.

Self-regist'ing Thermom.
Maximum Temperature .... 83°5 on p.m. of 1st } Monthly range=
Minimum Temperature .... 48°0 on a.m. of 16th } 35°5
Mean maximum Temperature .... 74°88 } Mean daily range=
Mean minimum Temperature .... 59°69 } 15°19
Greatest daily range ...... 23°5 from a.m. to p.m. of 28th.
Least daily range............ 3°0 from a.m. to p.m. of 25th.

Warmest day .... 1st... Mean temperature......... 75°12 } Difference = 18°60.
Coldest day .... 17th... Mean temperature......... 56°52 }
Maximum { Solar.................................... 102°5 on p.m. of 7th } Monthly range =
Radiation. } Terrestrial............................ 41°0 on a.m. of 19th } 61°5
Aurora observed on 6 nights, viz.,—6th, 15th, 17th, 18th, 19th, and 24th.
Possible to see Aurora on 14 nights; impossible on 17 nights.
Snowing on . days, depth ... inches; duration of fall, ... hours.
Raining on 15 days, depth 3.408 inches ; duration of fall 42.0 hours.
Mean of cloudiness = 0.64. Above average 0.19.
Most cloudy hour observed, 2 p.m: mean = 0.71; least cloudy hour observed, 8 a.m.; mean, = 0.60.

Sums of the components of the Atmospheric Current, expressed in miles.

North.	South.	East.	West.
1176.74	894.79	731.78	822.10

Resultant direction N. 18° W.; Resultant velocity 0.40 miles per hour.
Mean velocity ....3.89 miles per hour.
Maximum velocity ....21.0 miles, from 8 to 9 a.m. on 21st.
Most windy day ......21st............Mean velocity, 10.39 miles per hour. } Difference=
Least windy day......10th.............Mean velocity, 0.18 ditto. } 10.21 miles.
Most windy hour .... noon to 1 p.m.........Mean velocity, 6.49 ditto. } Difference=
Least windy hour...9 p.m. to 10 p.m.........Mean velocity 2.22 ditto. } 4.27 miles.

1st. Imperfect lunar halo at midnight.—2nd Thunderstorm 5.30 to 6 a.m.; and again from 8 to 9.50 p.m.—3rd. Dense fog from 2 to 8 a.m; sheet lightning at night.—4th. Distant thunder 3.30 p.m.; Sheet lightning at 8 and 10 p.m.—5th. Distant thunder in N.W. p.m., and fire-flies numerous.—7th Sheet lightning in N.W., 10 p.m. and midnight.—8th. Thunderstorm 4.30 to 7.15 a.m.; and again from 8 to 10.40 p.m.—10th. Ground fog, and fire-flies numerous at 10 p.m.—13th. Thunderstorm 4.30 to 10 p.m.—14th. Dense fog 6 to 8 a.m.—15th. Distant thunder 1.30 p.m.—23rd. Sheet lightning at 10 p.m. and midnight.—24th. Thunderstorm 2 to 3 a.m.—25th. Sheet lightning at midnight.—27th. Brilliant meteor at 8 p.m. in S.E.—28th. Lunar halo at 10 p.m.—30th. Thunderstorm 1 to 2 p.m.; ground fog at 8 p.m.—31st Thunderstorm between 10 and 11 p.m.

July, 1863, was comparatively mild, calm and cloudy.

COMPARATIVE TABLE FOR JULY.

YEAR.	TEMPERATURE.					RAIN.		SNOW.		WIND.		
	Mean.	Excess above aver'ge (66 8)	Max. ob-served	Min. ob-served.	Range.	No. of days.	Inches	No. of days.	Inches	Resultant. Direction.	Resultant. V'y.	Mean Force or Velocity.
1840	° 65.8	° — 1.0	° 79.4	° 48.2	° 31.2	6	5.270	...	...	...	...	....
1841	65.0	— 1.8	86.3	43.2	43.1	10	8.150	...	...	...	...	0.27 lbs.
1842	64.7	— 2.1	90.5	42.0	48.5	4	3.050	...	...	...	...	0.33
1843	64.5	— 2.3	86.1	40.2	45.9	8	4.605	...	...	...	...	0.44
1844	66.0	— 0.8	86.1	40.5	45.6	12	2.815	...	...	...	...	0.19
1845	66.2	— 0.6	94.6	45.6	49.0	7	2.195	...	...	...	...	0.30
1846	68.0	+ 1.2	94.0	44.9	49.1	9	2.895	...	...	...	...	0.29
1847	68.0	+ 1.2	87.5	43.8	43.7	8	3.355	...	...	...	...	0.19
1848	66.5	— 1.3	82.7	46.7	36.0	10	1.890	...	...	N 14° W	0.18	4.94mls.
1849	68.4	+ 1.6	89.1	51.0	38.1	4	3.415	...	...	S 5° W	0.75	3.52
1850	68.9	+ 2.1	84.9	52.8	32.1	12	5.270	...	...	N 81° E	0.59	4.56
1851	65.0	— 1.8	82.7	52.1	30.6	12	3.625	...	...	N 60° W	0.88	4.13
1852	66.8	0.0	90.1	49.5	40.6	8	4.025	...	...	N 43° W	0.93	3.33
1853	65.6	— 1.2	85.4	49.4	36.0	10	0.915	...	...	S 58° E	0.24	3.69
1854	72.5	+ 5.7	93.6	53.0	40.6	9	4.805	...	...	S 49° W	0.37	4.03
1855	67.9	+ 1.1	88.4	53.1	35.3	13	3.245	...	...	S 19° W	0.73	6.47
1856	69.9	+ 3.1	92.0	51.4	40.6	8	1.120	...	...	N 79° W	1.57	5.84
1857	67.8	+ 1.0	85.4	52.4	33.0	15	3.475	...	...	S 68° E	0.81	4.74
1858	67.9	+ 1.1	83.4	55.9	27.5	13	3.072	...	...	N 15° E	1.13	5.76
1859	66.9	+ 0.1	87.7	50.5	37.2	12	2.611	...	...	N 56° W	1.48	5.81
1860	63.9	— 2.9	85.8	47.5	38.3	13	4.336	...	...	N 60° W	2.15	7.29
1861	65.4	— 1.4	82.9	49.4	33.5	16	2.635	...	...	N 74° W	1.43	4.66
1862	66.7	— 0.1	88.6	52 6	36.0	15	5.344	...	...	S 89° W	1.42	5.80
1863	67.0	+ 0.8	82.3	49.3	33.0	15	3.408	...	...	N 18° W	0.40	3.89
Results to 1861.	66.85	...	87.21	48.32	38.89	10.0	3.490	...	...	N 65° W	0.49	4.91
Exc. for 1863.	+ 0.72	...	— 4.91	+ 0.98	— 5.89	+ 5.0	— 0.082	...	...	....	......	— 1.02

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THE

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NOVEMBER, 1863.

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⁂ *Communications to be addressed to the General Editor,* Prof. CHERRIMAN, *Univ. Coll.. Toronto.*

THE CANADIAN JOURNAL.

NEW SERIES.

No. XLVIII.—NOVEMBER, 1863.

A GLANCE AT THE POLITICAL AND COMMERCIAL IMPORTANCE OF CENTRAL BRITISH AMERICA.

BY H. Y. HIND, M.A., F.R.G.S.

Communicated to the Canadian Institute, November, 1863.

The extraordinary commercial activity to which steam and the electric telegraph have contributed of late years, lead us to overlook the enterprise and daring which distinguished the early French colonists of Canada nearly two centuries ago. The history of their successful attempts to open commercial intercourse with Indian nations to the north and north-west, far beyond the present limits of Canada, their journeys of discovery and military expeditions to the shores of Hudson's Bay, appear to have faded from the recollections of their descendants, at a time when the question of extending our civilization into the far interior of the continent is exciting general attention both in England and Canada.

If the proposal were now gravely made to send an armed force of one hundred and fifty soldiers, or one hundred and fifty emigrants, across the uninhabited wilderness between Lake Superior and James Bay, or between Quebec and Hudson's Bay, to establish permanent settlements, a large majority of the public would treat the idea as simply absurd, and the projectors as probably insane.* Yet these expeditions were actually undertaken when the population of the whole of Canada was less than one-fifth part of the present population of Montreal, and, consequently, less than one half the population of Toronto.

That the early French colonists were pre-eminently distinguished by their desire for the extension of their territory, the following extracts from the Paris documents† will establish beyond doubt, and at the same time convey some idea of their activity and enterprise in the infancy of Canadian history, and also of the projects they formed, and the conceptions they entertained of the extent of the country they intended to colonize as new France, north of the great Lakes, two hundred years ago.

As early as 1646, we read that Sieur Bourdon, with three Frenchmen, was sent overland from Quebec, to take possession of Hudson's Bay for France. The French had already established a trade with the Indians of Hudson's Bay, and in a few years induced them to come to Quebec to barter their furs.

In 1661, the Rev. Claude Dablon set out overland for Hudson's Bay viâ the Saugenay, but he succeeded in reaching only the head waters of the Nebouka, 300 miles from Lake St. John.

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* Persons who pretended to be familiar with the difficulties of the overland route from Canada to British Columbia, were only too ready to predict the disastrous failure of the Canadian emigrant party of 1862 to reach British Columbia in one season, "supposing they escaped the Indians and starvation."

Probably there is no stretch of country in the world exceeding one thousand six hundred miles in continuous length, and wholly in a state of nature, which it would be possible for one hundred and fifty people, including a woman and three children, to traverse during a single season, overcoming such apparently formidable obstacles as the Rocky Mountains have been supposed to present. The simple fact that these emigrants were enabled to take a large number of oxen and horses through the mountains, by an undescribed Pass, supplies a most satisfactory answer to those who have uniformly represented the dangers and difficulties of a route across the continent within British Territory, as insuperable without extraordinary outlay. Here we have an instance of a large party of emigrants, nearly all unaccustomed to the work, effectually combating those difficulties, and proving that they were either grossly exaggerated or in a great part imaginary. Another important fact which this journey has developed, is the ease with which the Fraser river is capable of being navigated by canoes or rafts, as far down the stream as the forks of the Quesnelle, the point from which a road will most probably strike off in a nearly direct line to the Pacific, touching the ocean at one of those deep indentations which form so curious a feature of the British Columbian Coast. There can be no doubt that great privations were endured by many of the party, but at least until they reached the Fraser, there are, happily, no sad memorials left on the route they took, like those which distinguish every mile of the inhospitable desert which separates the valley of the Mississippi from the Pacific States and Territories of the United States.

† Documents relating to the Colonial History of the State of New York.

"In 1663 the Indians of the Bay du Nord (Hudson's Bay) returned to Quebec in further quest of Frenchmen, and M. Davaugour sent thither Sieur de la Couture with five men, who proceeded *overland* to the said Bay, possession whereof he took in the King's name, noted the latitude, planted a cross, and deposited at the foot of a large tree his Majesty's arms engraved on copper, and laid between two sheets of lead, the whole being covered with some bark of trees."

In 1671 Pere Albanel was despatched overland to Hudson's Bay by the Intendant Talon, (*viâ* the Saugenay River); and in the same year (1671) Sieur de St. Lusson was sent by Mr. Talon to Sault St. Marie, where he made a treaty with "seventeen Indian nations." The Intendant in his report states that the place Sieur de St. Lusson reached is not supposed to be 300 leagues from the extremities of the countries bordering on the Vermilion or South Sea. He continues: "The countries bordering on the Western ocean appear to be no farther from those discovered by the French, according to the calculation of the distance made from the reports of the Indians; and by the maps there does not appear to be more than 1500 leagues of navigation remaining to Tartary, China and Japan." Even at so early a period in the history of Canada did the French look forward to establishing communication, overland, with the "South Seas," to command the trade of Western Asia; and in another half century the French government were so impressed with the idea of an overland route to the Pacific that they sent instructions to Quebec to have the exploration effected.

Du Chesneau writes in 1681: "They (the English) are still at Hudson's Bay, on the north, and do great damage to our fur trade."

In 1683 M de la Barre writes to M. de Seignelay: "The English of Hudson's Bay have this year attracted many of our northern Indians, who for this reason have not come to trade to Montreal. When they learned by expresses, sent them by Du L'hut on his arrival at Missilimakinak,* that he was coming, they sent him word to come quickly and they would unite with him to prevent all the others going thither any more. If I stop that Pass (Lake Superior to James Bay), as I hope, and as it is necessary to do, as the English of that Bay excite against us the savages, whom Sieur du L'hut alone can quieten, I shall enter into arrangements with those of

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* Michillimakinak, Green Bay, and Lake Huron.

New York, for the surrender to me of any guilty fugitives, but we are desirous to obtain an order to that effect from the Duke of York."

And in the same year (1683) M. de la Barre writes to M. de Seignelay as follows: "A small vessel has just arrived from Hudson's Gulf, 200 leagues further north than the Bay. * * * It is proper that you let me know, early, whether the King desire to retain that post, so that it may be done, or the withdrawal of the French, for which purpose I shall dispose matters in order TO AID THEM OVERLAND beyond Lake Superior, through Sieur Du L'hut, and to send to them by sea to bring back the merchandise and peltries."

In Governor Dongan's Report on the State of the Province, in 1687, we find a notice of the Hudson's Bay in the New York Colonial manuscripts:* "Last spring he (the Governor of Canada) sent one De la Croa with fifty soldiers and one hundred young men of Canada to the north-west Passage, where, I am certainly informed from Canada, they have taken three forts."† In Mr. Nelson's memorial about the state of the Northern Colonies of America, dated 1696, he says "there are actually, this instant, now at Versailles six Sagamoes or chiefs sent from Canada, Hudson's Bay, and Nova Scotia, to solicit such help and assistance against us," &c., &c.

M. de la Veranderie was sent on an overland expedition by the desire of Count Maurepas, in the year 1738, to discover the Pacific Ocean. He set out with his party from Montreal, passed through Lake Superior, and proceeding nearly due west, ascended the Assinniboine river, and directed his course towards the Rocky Mountains. Without reaching the Rocky Mountains, M. de la Veranderie was obliged to abandon the prosecution of his expedition. Three hundred miles west of Lake Winnipeg on the Assinniboine river, the French erected Fort la Reine. Three others were built further west, the most remote of which stood on the bank of the River Paskoyac.‡

Mackenzie speaks of Canadian missionaries who penetrated "2800 miles from the civilized parts of the Continent long before the cession of the country to the English in 1763!

The names of several lakes and prominent hill ranges date from the occupation of the country west of Lake Winnipeg by the French prior to the Conquest. Such as Dauphin Lake, Dauphin Mountains; Fort Bourbon, on the Saskatchewan, near the west end of Cedar Lake. The most remote of the French settlements on the Saskatchewan appears to have been, "at Nipawee, in lat. 53½ long. 103."*

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*Documents relating to the Colonial History of the State of New York.

† Governor Dongan refers to Chevalier de la Troye—an account of whose Expedition to Hudson's Bay, in 1686, is contained in Charlevoix's History.

‡ Foot note to New York Colonial Manuscripts; Paris Doc.

When we consider these great enterprises in connection with the population of Canada at the time, we cannot fail to be astonished at the energy of the French colonists, and the desire they exhibited to extend their empire even to the frozen North, and to secure the overland trade with Hudson's Bay and the far unknown west—even to "South Seas."

During the period when they were undertaken, the population of Canada from 1666 to 1738† was as follow:—

1666	3418—total population. 1344—men bearing arms.
1667	4312—total population. 1566—men capable of bearing arms.
1668	5870—total population. 2000—men capable of bearing arms.
1679	9400—total population.
1685	17,100—French inhabitants, men, women, and children. 3000—men capable of bearing arms.
1738	45,000--population: the year M. de la Verandèire was sent overland to discover the Pacific Ocean.

At the period of which we write Upper Canada and a large portion of Lower Canada was a wilderness, and yet the French sought to extend their territorial jurisdiction to the shores of Hudson's Bay; and some years later, had visions of grasping the Indian and China trade from the shores of the Pacific, which they hoped to reach overland from Canada.

At the present time Canada numbers some 2,700,000 souls, and we have the official statement from the highest authority, that the best lands in the country have already been sold.* With this unexpected and startling announcement before us, we are justified in assuming that the present surveyed lands of the Province on the north side of the St. Lawrence, determine with considerable accuracy the boundaries of the portion likely ever to be settled with an agricultural population, and, until manufactures spring up, they are a rude measure of the future increase in our population through immigration.

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* The name "Nipawee" is perhaps the same as Nepowewin or "The Standing Place," the present name of the mission opposite Fort à la Corne. Before the conquest the French had settlements at Dauphin Lake, the Pasquia (near Carrot river or Root river) and at Nipawi, "where they had agricultural instruments and wheel carriages, marks of both being found about the settlements."—*Mackenzie's Voyages.*

† Paris Documents.

Lumbering operations are constantly retreating farther North, and must soon find their limits; but they merely sweep the wilderness of its best forest growth, and do not lead to permanent agricultural settlements if the soil be not favourable. Emigrants prefer to go farther West in search of good land, and if this is not to be found in Canada they must betake themselves to the United States, or to Central British America. We cannot look to mining enterprise as at all likely to lead to centres of population in the back country north of the St. Lawrence, for very many years to come. Iron and copper ores exist in almost unlimited quantities within a few miles of the shores of the Great Lakes or great rivers, and, indeed, in Lower Canada, within easy reach of the Grand Trunk Railway, and they are much nearer to coal, and to markets, than the mineral wealth of the back country.

That part of the valley of the St. Lawrence which lies within the limits of Canada, occupies about 330,000 square miles, and of this portion 280,000 square miles lie wholly on the north side of the St. Lawrence. By far the greater portion of this vast region is intersected with lakes, and " the profusion in which the lakes exist, with, in some instances, only a short interval of land between them, though they may belong to different river-systems, affords with the aid of birch-bark canoes, a ready means of passing from one navigable stream to another, in whatever part an explorer may be; and then, if he is well acquainted with the country, he can reach almost any position he may wish to attain without any very great deviation from a direct route."†

The length of the Province of Canada from Quebec to the Fort William, on Lake Superior, is about 1100 miles, and the greatest depth likely to become well settled north of Lake Ontario and the River St. Lawrence is 120 miles. On the banks of the Ottawa and some of its tributaries, and of the St. Maurice, this distance may ultimately be increased by a few miles, but on the shores of Lakes Huron and Superior it is far from probable that any but thin and sparse agricultural settlements are possible, even in the rear of the Lakes. Excluding the peninsula portion of Western Canada, the average depth of the country available for agricultural settlements does not exceed 75 miles between Quebec and Fort William. Excluding the North Shores of Lakes Huron and Superior, we have the probable limits of Canada as an agricultural country, defined by a frontier 800 miles long by 100 miles deep, on an average, on the north side of the St. Lawrence. All the best land in Canada is sold; in what direction then can British settlements extend by immigration? assuming that the natural increase of the present population is sufficient to occupy the profitable wild lands already owned by private individuals. The fact is, that Canada is really nothing more than a narrow fertile stripe, 1000 miles long and 75 miles broad on an average,—backed by an undulating mountainous region, susceptible only of agricultural settlements in valleys neither numerous nor broad, considering the immense area occupied by this region.

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* It is the fact that the best lands of the Crown in both sections of the Province have already been sold. The quantity of really good land now open for sale, is, notwithstanding recent surveys, much less than formerly, and is rapidly diminishing.—*Report of the Commissioner of Crown Lands for* 1862.

† Report on the Geology of Canada.—By Sir W. E. Logan, F.R.S.

It is clear then, that in order to preserve our nationality in the face of the astonishing strides towards wealth and political importance which have been made by the United States, we must strengthen our position by extending British civilization where there is room for it to grow and expand.

The North, as an agricultural region, is practically closed against us by the conditions of soil and climate, although it contains abundance of inert wealth, which may yet become productive and valuable.

The East is already preoccupied: the West alone remains to us. We are separated from Central British America by six degrees of longitude, which must be traversed before we can reach a region possessing a soil of remarkable fertility, and occupying a greater extent of surface than the whole available portion of Canada; abounding also in iron ores of the richest description, salt, and lignite coal, and almost entirely unoccupied by man. This barrier has frequently been upheld as an insuperable objection to a practicable commercial communication between Canada and Central British America, in the absence of correct knowledge of the physical features of the country. The utmost length of the barrier which requires the construction of a road, scarcely exceeds 200 miles. From its western extremity there is an unobstructed navigation, with but one break, to the edge of the fertile prairies of Central British America *via* Rainy River and the Lake of the Woods ; and its eastern extremity is connected uninterruptedly with the sea by the Great Lakes and the St. Lawrence. The highest point over which the road from Lake Superior to the northern indent of Rainy Lake must pass, is not 900 feet above Lake Superior ; and for the first 30 miles it would traverse a country susceptible of tillage for several miles on either side. Then follows a sudden rise, marked by the great Drift bank of Dog Lake, which forms the Eastern limit of a Drift-covered country stretching in a north-east and south-west direction, and having a breadth of about ninety miles where the road would cross it. This accumulation of Drift covers the height of land to a depth certainly exceeding 150 feet, as shown by the hills at the summit level at Prairie Portage, 885 feet above Lake Superior, and the highest point on the line of road. There are no serious physical impediments to overcome between Lake Superior and the northern indent of Rainy Lake, either for a waggon road or a railway ; and this short link of 200 miles completed, the distance between Fort William on Lake Superior and the commencement of the arable prairies of the valley of Red River would be reduced to 200 miles of road or railroad, and 180 miles of steam navigation. Here, then, we see no formidable impediments, which an impression derived from the custom of traversing the country in canoes through the rocky channels of rapid rivers or hill-embosomed lakes, had created in the minds of the few who have traversed that region ;—impressions which, too eagerly accepted by the public, notwithstanding the imperfect knowledge of the physical conformation of the country, which a rapid journey without special geographical objects in view is fitted to obtain, have retarded the settlement of the fertile prairies of Red River.

The communication between Central British America, British Columbia, and the Pacific Ocean, is the next point to be considered. The recent successful journey across the Rocky Mountains of the Canadian emigrant party of 1862, by an old and long unused trail, called the "Old Columbia Trail," with numerous horses and oxen, dissipates all fears for the passage of the Rocky Mountains. Where 70 horses, 130 oxen, and 150 men, women, and children can journey without difficulty, the road still being in a state of nature, it is reasonable to suppose that a small expenditure would convert it into an excellent waggon road.

The Miette Pass and the Thompson's River trail, join Cariboo with the Plains of the Saskatchewan,* and Cariboo is now only seven days' journey from New Westminster—thanks to the energy which has pushed the government roads so rapidly through that "impassable" wilderness, as to bring the crests of the Rocky Mountains within a week's travel of the Pacific seaboard.

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* The Canadian Emigrant party of 1862, took through the mountains 130 oxen and about 70 horses. When in the mountains, they killed a few oxen for provisions; others were sold to the Indians at Tête Jaune Câche, on the Fraser; and others were *rafted* down the Fraser River to the Forks of the Quesnelle. At the Tête Jaune Câche, a portion of the party separated from the rest, and, with fourteen horses, went across the country by an old well-worn trail to Thompson's River, and thus succeeded in taking their horses from Fort Garry through the Rocky Mountains—through a supposed impassable part of British Columbia, to the wintering station on Thompson's River and Kamloop's Lake, for the pack-animals of the British Columbia gold-seekers.

The Leather, or Miette Pass, lies in latitude 54°, and has long been known to the employees of the Hudson's Bay Company, and is called by them the "Old Columbia Trail," or "Jasper Pass." It will be observed that it forms an immediate and direct connection with the great artery of British Columbia, namely, the Fraser River. The other passes to the south connect with the Columbia River, which flows for many hundred miles through Washington territory. It will not fail to be noticed, too, that the existence of this route viâ the Leather Pass, has only very recently appeared on published maps. It is shown on Arrowsmith's Map of British Columbia, published in 1860; but the success with which its long-established connection with the Fraser was concealed by the late Hudson's Bay Company, is a singular instance of the unity of purpose which has pervaded all the actions of that powerful corporation during their long tenure of absolute control over a portion of British America, containing more land suitable for the abode of man than the Province of Canada itself, and which has already cost in its defence from aggression many millions of money and many thousands of lives. It seems remarkable that the Leather Pass and its easy connection with the Fraser River, escaped the attention of the exploring party sent by the British Government, under Captain Palliser, in 1857, 1858, and 1859. If the existence of this unobstructed communication between the Athabaska Valley and British Columbia had been made known to the world as one of the results of that expedition, probably long ere this the British Government would have taken measures to establish a separate government in Central British America, and open a communication across the continent through British territory. Dr. Hector actually passed the "Old Columbia Trail," but neither his guides nor the people at St. Ann's or Edmonton appear to have informed him of its existence. Fortunately the Leather Pass has now been traversed by men, a woman, children, and numerous oxen and horses;—the Fraser River has been safely descended for four hundred miles from its source, in canoes and on rafts, by a very numerous party, and it has been *ascended* in a boat from Cariboo to the Tête Jaune Câche; and from this last-named place there is a well-known trail for horses to the Thompson River, and thence to New Westminster, which has also been traversed by Canadian emigrants with horses; and more recently, according to Victoria papers, by Lord Milton, with thirteen horses. The difficulties of the Rocky Mountains have in great part melted away, and the "impossibilities" of the overland route have vanished, just as the "uninhabitable deserts and swamps" of the Saskatchewan have given place to boundless fertile prairies, which will probably become—even in our generation—the seat of an enterprising and prosperous people.

It is not, perhaps, unreasonable to anticipate that difficulties of a political character will arise between the Northern and Southern States with reference to the American telegraph and Pacific railway, as now constructed and contemplated, on and near the 32nd parallel. The route offering most advantages next to that running near the 32nd parallel (the one selected), is the Northern Route, or that lying between the 47th and the 49th parallels. But since the survey of it was made, the passes in the Rocky Mountains have become better known, and there can now be little doubt that the Leather or Miette Pass is between 2,000 and 3,000 feet lower than the pass on the 47th parallel.

It is, however, the remarkable character of the country through which a railway or postal road from the Lake of the Woods to the Miette Pass would traverse, which gives this line of route an extraordinary prominence. The present President of the Southern States, when Mr. Secretary Davis, summed up the comparisons of the different routes in the United States, as regards the character of the country they traverse. The following is an abbreviation of the summary:

	MILES.
Route near the 47th and 49th parallels, from St. Paul to Vancouver..	1,864
Number of miles through arable land............................	374
Number of miles through land generally uncultivable, arable soil being found in small areas..................................	1,490

The greatest number of miles of route through arable land on any one of the lines surveyed, is 670 miles, in a distance of 2,290 miles. The least number of miles of route through generally uncultivable soil, is 1,210, on a line of 1,618 miles in length, near the 32nd parallel.

From the Lake of the Woods, or from Pembina, a line in British territory instead of passing through a desert incapable of supporting human life, would traverse a fertile belt of country, averaging one hundred miles in breadth,* fully able to sustain five times as many people as Canada now possesses, and leading directly towards the lowest and by far the most facile pass in the Rocky Mountains.*

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* The arid region of the Missouri valley commences west of the 100th degree of longitude; but the 100th degree of longitude divides the United States into two nearly equal parts on the 40th parallel of latitude. The eastern half is the present fertile and peopled part of the country. The western half is a comparative desert all the way to the Pacific. It is in comparison with this immense desert that the fertile belt at the edge of the woods, stretching in the Saskatchewan Valley from the Lake of the Woods to the Rocky Mountains, stands out in such surprising contrast. Sixty thousand square miles of arable land in Central British America, mark out the true pathway across the continent, which alone is capable of sustaining an efficient means of com-

Apart from the advantages which Central British America affords as a railroad route over any portion of the United States, the direction and magnitude of its navigable lakes and rivers are of the utmost importance. These border on, or directly traverse, the Fertile Belt, and thus afford a splendid means of access by steamer from Red River to within 200 miles of the Rocky Mountains.†

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munication, whether in the form of a stage road or ultimately of a railway, by the growth of a local population. But the favourable comparison does not rest here. The mountain region, which offers such a difficult barrier to communication between the Pacific and the valley of the Mississippi, possesses peculiarities in British America which are in themselves of a very striking character, and quite sufficient to establish the line of route, cutting diagonally the 50th, 51st, 52nd, and 53rd parallels, as far superior in point of physical conformation to any other lines of route which have been explored in British America or the United States.

* Table of comparison between the different passes in the Rocky Mountains, in the United States and in British territory, north of latitude 38°:—

United States—	Altitude of Pass.—Feet.
Surveyed Route between the 38th and 39th parallels of latitude	10,032
Route between the 41st and 42nd parallels	8,373
Route between the 47th and 49th parallels	6,044
British territory—	
Kananaski Pass, from the South Saskatchewan to the Kootanie River	5,985
Kicking Horse Pass, from the South Saskatchewan to the Columbia	5,420
Vermilion Pass, from the South Saskatchewan to the Kootanie River	4,944
"Old Columbia Trail," or Leather Pass, from the Athabasca to the Fraser—the Canadian emigrant route—probably below	4,500

The breadth of country forming a continuous mountain region is far greater in the United States than in British America. The United States is crossed by three great systems of mountains, extending generally from north to south. The first system, beginning with the Sierra Madre, and terminating in the Black Hills of Nebraska territory, is partially gorged by the Rio Grande, completely cut through by the North Platte and the Sweet Water Rivers, and turned by the Missouri. It does not extend into British America. The total breadth of mountainous country, in the proper acceptation of the term, within the limits of the United States, varies from 500 to 900 miles. In British Columbia, the greatest length is not more than 380 miles from the Leather Portage to the Pacific; and the actual distance, in an air line, from the Leather Portage to the extremity of Belhoula Inlet, the possible terminus of a route, does not exceed 400 miles.

† The successive links in a road and steam navigation across the Continent through British America may be as follow:—

1. Road from Fort William to the northern indent of Rainy Lake, *viâ* the MATAWAN River	200
2. Steam from the northern indent of Rainy Lake to the Falls opposite Fort Frances	40
3. Steam from Fort Frances to the north-west corner of Shoal Lake (Lake of the Woods)	130
	370
4. Road from Shoal Lake to Fort Garry	90
5. Steam from Fort Garry to the Grand Rapids of the Saskatchewan	280
6. Steam from Grand Rapids to Edmonton	700
7. Edmonton to the Frazer, *viâ* Miette or Leather Pass, by Road	290
Total distance from Lake Superior to Frazer River—Road, 580; Steam, 1150	1730

If an inclined plane or a short canal were constructed at the Grand Falls of the Saskat-

It now remains to glance at the intrinsic worth of the Southern part of Central British America in its agricultural aspects and its mineral wealth as far as known.

The area of cultivable land of the first quality is estimated to be not less than 80,000 square miles, extending from the Lake of the Woods to near the head waters of the Athabasca, and in a narrow stripe on the east flank of the Rocky Mountains as far south as the fiftieth parallel of latitude. The length of this Fertile Belt is about 800 miles, the mean breadth 100 miles, and it is susceptible of cultivation or depasturage throughout. It is capable of sustaining an agricultural population equal to that of the Kingdom of Prussia. The basin of Lake Winnipeg alone, is capable of sustaining an equally numerous population. It contains several million more acres of arable land than the Province of Canada.*

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chewan, there would be an uninterrupted navigation for shallow steamers—such as ply on the Upper Missouri—from Georgetown on Red River, already in communication by stage with St. Paul, and Edmonton, within 200 miles of the Rocky Mountains. The dimensions of the Grand Falls or Rapids of the Saskatchewan are—2¼ miles long, and a total descent of 43½ feet.

* The agricultural capabilities of the Basin of Lake Winnipeg may be summed up as follows:—

	Acres.
On the route from Fort William, Lake Superior, to the Lake of the Woods, including the valley of Rainy River	200,000
The Fertile Belt, stretching from the Lake of the Woods to the flanks of the Rocky Mountains, and as far north as the 54th parallel, on the Athabaska, west of McLeod's River, (80,000 sq. miles)	51,200,000
Isolated areas in the Prairie Plateau, south of the Assinniboine	2,000,000
Isolated areas in the great Plain Plateau, the extension northwards of the great American Desert, and in the valleys of the rivers flowing through it	1,000,000
Total area of Land available for agricultural purposes	54,400,000
Approximate area suitable for grazing purposes	30,000,000
Total approximate area fitted for the abode of civilized man	84,400,000
Approximate area of the Basin of Lake Winnipeg, within British Territory	199,680,000
Area fitted for the abode of civilized man	84,400,000
Desert area unsuitable for the permanent abode of man	115,280,000

Comparing this extent of surface with Canada, we arrive at the following results:—

	Acres.
Area of the Province of Canada (340,000 square miles)	217,600,000
Area occupied by the Sedimentary Rocks (80,000 square miles)	51,200,000
Area occupied by the Crystalline Rocks	166,400.000
If we suppose that one-sixth of the area occupied by the Crystalline Rocks is capable of cultivation, as regards soil and climate, (an estimate probably in excess) the total amount of land in Canada available for the purpose of settlement, will be approximately	78,900,000
Showing an excess of land fitted for the permanent abode of man, in favor of the Basin of Lake Winnipeg over the Province of Canada, of	5,500,000

In Upper Canada, with a population of 1,396,091, there are 13,354,907 acres held by proprietors, of which only 6,051,619 acres are under cultivation, cropped or in pasture. If the

Winter wheat has recently been tried at Red River Settlement with complete success, and all vegetables which will grow in Canada East succeed well at Red River. The mineral wealth of this vast central region is but partially known. Already the existence of extensive beds of Lignite coal on the Upper Saskatchewan and its tributaries have been determined.*

With the lignite coal are also found vast deposits of clay iron-stone. These extend much further east than the lignite layers, which have been removed by denudation, and form a very peculiar and important feature in the rocks west and south of the Assinniboine after it makes its north-westerly bend.†

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whole quantity of land fit for cultivation were occupied in the same proportion, the population of Canada would exceed eighteen millions. At the same ratio of inhabitants to cultivable and grazing land, the Basin of Lake Winnipeg would sustain a population exceeding 19,000,000, or leaving out of consideration the land suitable to grazing purposes, its capabilities would be adapted to support 12,000,000 people. If European countries such as France and Great Britain were taken as the standard of comparison, or even many of the States of the American Union, the number would be vastly greater.

The arid region of the great American desert, which places an uncultivable and uninhabitable wilderness between the present north-westerly settlements in Nebraska and the Rocky Mountains extends into British America only in the form of the apex of the cone shaped figure it has on the map, with its base in the high lands of Texas and Mexico.

* A large part of the region drained by the North and South branches of the Saskatchewan is underlaid by a variety of Coal or Lignite. On the North Saskatchewan coal occurs below Edmonton in workable seams.

A section of the river bank in that neighbourhood shows in a vertical space of sixty feet three seams of Lignite, the first one foot thick, the second two feet, and the third six feet thick. Dr. Hector, who made the section, states that the six foot seam is pure and compact.(*a*) Fifteen miles below the Brazeau River, a large tributary to the North Saskatchewan from the west, the lignite bearing strata again come into view, and from this point they were traced to the foot of the Rocky Mountains. On the Red Deer River the lignite formation was observed at various points. It forms beds of great thickness; one group of seams measured twenty feet, " of which twelve feet consisted of pure compact coal," (Dr. Hector.) These coal beds were traced for ten miles on Red Deer River. A great Lignite formation of cretaceous age containing valuable beds of coal has a very extensive development on the upper waters of the North and South Saskatchewan, the Missouri, and far to the north in the valley of the Mackenzie. Col. Lefroy observed this Lignite on Peace River, and Dr. Hector recognized it on Smoking River, a tributary of Peace River, also on the Athabaska, McLeod River and Pembina River, all to the north of the Saskatchewan, " thus proving the range of this formation over a slope rising from 500 to 2,300 feet above the sea, and yet preserving on the whole the same characters, and showing no evidence of recent local disturbance beyond the gentle uplift which has effected this inclination."(*b*)

† The vast deposits of iron ore belonging to the cretaceous series of the Basin of Lake Winnipeg acquire especial importance in consequence of their being associated with equally widely distributed deposits of lignite, and are found not very remote from apparently inexhaustible stores of bitumen and petroleum (on Clear Water River,) which as a fuel adapted to raising elevated temperatures in a regenerating furnace has no equal.

(*a*) Proceedings of the Geological Society, 1861, page 421.

(*b* *Ibid*, page 420.

Salt is widely distributed, and the rocks yielding this material have been traced from the boundary line beyond the Saskatchewan towards Lake Athabaska.*

Gold is known to exist throughout the Drift on both the branches of the Saskatchewan and its tributaries. Gold has also been found on the Assinniboine, and on some of the tributaries leading into the Qu'appelle or Calling River, hence, reasoning from known facts respecting the source and direction of the Drift which covers the country within 150 miles of the Rocky Mountains, there is the best ground for the belief that the source of the Assinniboine gold lies on the east side of the Basin of Lake Winnipeg, and will be found in altered Silurian rocks (already recognized) reposing on the Laurentian strata which form the east shore of Lake Winnipeg, and stretch thence towards Lake Athabaska.

The extensive bituminous deposits which occur on Clear Water River belonging to the Athabaska† valley, deserve mention, as valuable deposits in store for future use.

In contemplating the future of Central British America one important feature appears to be neglected, if not entirely overlooked. While Lake Winnipeg is 2500 miles from the sea board of the Gulf of St. Lawrence, and lies exactly in the centre of the American Continent under the 51st parallel, its northern extremity is only 380 miles from the tide waters of Hudson's Bay.

The mouth of the Saskatchewan is as near to the open sea as Fort

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* This important material is distributed throughout a large part of the valley of Red River, the basin of Lakes Manitobah and Winnepegoosis, and thence north-westerly towards the Arctic Sea; the Brine Springs occur at the junction of the Silurian and Devonian rocks of the Winnipeg Basin, and have already yielded salt of excellent quality in several localities. Many years ago (1823) salt was manufactured at Pembina, and more recently at the salt works, Manitobah Lake, by Red River natives, and at Swan River by the Hudson's Bay Company. Springs rich in brine are known to exist in upwards of twenty different places along a stretch of country extending from the boundary line to the Saskatchewan. In the valley of La Rivière Sale, about twenty-six miles from Fort Garry, salt springs are numerous, and the ground in their vicinity is frequently covered with a thick incrustation.

† Although the Athabaska district, as a whole, may be remote from the line of settlements which will be first established across the continent, yet it is a vast territory in reserve, and one which as time rolls on will become peopled with a pastoral race, and eventually exercise an important influence upon the more fertile and arable districts ef the North Saskatchewan. As a great grazing country it will early attract attention; and its vast stores of bitumen will be a source of great utility where portable fuel and means of creating artificial light must command a remunerative price, when the increase of population calls into existence those necessaries which belong to civilized communities. The Athabaska district should by no means be shut out of view in contemplating the future of the Basin of Lake Winnipeg. Its proximity to the auriferous valleys of the west and east flanks of the Rocky Mountains will soon secure for it a conspicuous position in the future of the North-West.

Garry is to the western extremity of Lake Superior. The passage from Norway House, at the northern extremity of Lake Winnipeg, to Hudson's Bay is made in nine days with loaded boats. It is not unreasonable to suppose that by the introduction of tramways over the portages, the journey may be made in four days, thus bringing Lake Winnipeg within four days of the Sea, yet the nature of the communication now followed is such that it would not admit of vessels much larger than freighter's boats being employed. The navigation of Hudson's Bay for sailing vessels is safe for a period not exceeding six weeks—for steamers it may be double that time. Hitherto the mode of communication adopted by the fur traders between Norway House and Hudson's Bay has been sufficient for the exigencies of the fur trade; it is not at all improbable that more easy means of communication with the sea board exists than those which are now pursued. Under any circumstance it is a fact of the highest importance that Lake Winnipeg is actually within a week's journey of the ocean, over a natural road by which troops have already entered and departed from Central British America. It is more than probable that whenever the necessity arises, the communication between Lake Winnipeg and Hudson's Bay, and thence to the Atlantic, by the aid of steamers, will be made easy and speedy for at least three months in the year.

The outlet by which the waters of the Saskatchewan and Lake Winnipeg reach the sea, is Nelson River. The chief reason which induces the Hudson's Bay Company to send their cargoes of furs to York Factory by Hayes River, is stated to be the difficulties and dangers of the tracking ground on the banks of Nelson River, arising from impending masses of ice on the precipitous banks. The head of tide-water in Nelson River may yet become the seat of the Archangel of Central British America, and the great and ancient Russian northern port—at one time the sole outlet of that vast empire—find its parallel in Hudson's Bay.

It has been shown that the natural resources of Central British America are amply sufficient to sustain a large population. The existence of gold over wide areas in the Drift which covers the country, will ensure a rapidly increasing immigrant population, which, from the nature of their occupation, will necessarily be consumers of agricultural and manufactured products, so that there will be, for some years to come, a home market for whatever the soil can produce, which will soon extend to home manufactures of the coarser description.

Meanwhile communication with British Columbia under the projects contemplated by the new Hudson's Bay Company will rapidly progress, and also with Canada *viâ* Lake Superior, and the United States *viâ* Red River and St. Paul.

Apprehensions may arise that the present easy access which the navigation of Red River offers to immigrants from the States will, in view of various circumstances gradually developing themselves, introduce a population to the fertile valley of the Saskatchewan, hostile to British Institutions and British connection.

The grounds for these apprehensions are as follow:

First: The limit which the American Desert establishes to the westward progress of settlement in the States. This limit is about one degree of longitude west of Fort Garry* and beyond it, south of the boundary line, large agricultural settlements cannot extend in Minnesota or Nebraska, or further south than these states; nor north, even in Central British America, until the limits of the "Fertile Belt" are reached.

Second: The necessity for a new line of Pacific Railway other than that near the 32nd parallel, adopted by the United States Government, which lies within the country claimed by the Southern States.

Third: The incomparable superiority of the country in Central British America for a railroad or postal route to the Pacific to any part of the United States north of the 32nd parallel. This superiority consists in the line of route passing through rich arable land to the foot of the Rocky Mountains, in contradistinction to an uninhabitable desert through which a railroad or common road would have to pass in any part of the United States; and also to the low altitude of the Pass in the Rocky Mountains.

Fourth: The existence of gold widely distributed, and in quantities, according to the latest intelligence, amply sufficient to prove remunerative to the industrious miner, not only on the east flank of the Rocky Mountains but also in the Drift, near the western shores of

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* The longitude of Fort Garry is 95°, 52′ 27″, latitude 49° 52′ 6″. Pembina Mountain which marks the limit of the good land in the State of Minnesota, west of Red River, is on an average about thirty miles distant from the River. Beyond the 101st degree of longitude in the United States, agricultural settlements on a large scale are not possible on account of aridity.

Lake Winnipeg, with the probability of its matrix being found both in the Rocky Mountains and also near the western flanks of the Laurentian Range.

As opposed to these apprehensions we have,—

First: The comprehensive scheme of settlement proposed by the new Hudson's Bay Company, which will tend to people the valley of Red River and the Saskatchewan with settlers possessing British sympathies, and the strongest attachment to British rule.

Second: The fact that the best lands in Canada are now sold, and immigrants will prefer to go farther west in search of cheap available *prairie* land of the best description in Central British America, to settling on the comparatively poor *timbered* lands which yet remain in Canada at the disposal of the government.

Third: The manifest eagerness with which the people of Canada look forward to the opening of an easy, and rapid communication between Lake Superior and Red River, and the unanimous determination which exists amongst all classes to uphold British rule on British soil.

Fourth: The material assistance ($50,000 per annum) which the Canadian Government, and the Government of British Columbia ($50,000 per annum), propose to render the Hudson's Bay Company in providing a rapid and easy means of communication across the continent through British territory, and in the construction of a telegraph, already commenced, to connect the Pacific with the Atlantic Ocean, also through British America. The electric telegraph annihilates distance, and will, when completed, unite all parts of this vast dominion and, in effect, bring it within reach of the central or governing power.

Fifth: The prospect of not only regaining, on a vastly enlarged scale, extending to China and Japan, the lucrative transit trade which in the time of "The Nor'-West Company" enriched so many of our merchants, but also that prospective trade which must necessarily spring up with a country abounding in all things suitable for the maintenance of a large population, and whose course towards the ocean lies naturally through the St. Lawrence, and in its most direct line seaward, exclusively through British America.

Sixth: The consciousness that the physical difficulties which oppose the direction of that trade in the desired channel, are of such a character as the means now at the disposal of those who have already taken the matter in hand can successfully and easily overcome.

And lastly: The growing conviction among the people of British America, and of many in England, that the maintenance of British rule over that portion of the American continent is in a great measure dependent upon united action on the part of the different Colonial Governments, which must ultimately, and perhaps soon, lead to a closer union between them, in the form of a Federation and Vice-Royalty, under the protection of, and in intimate alliance with, the British Crown.

A necessary preliminary step in the establishment of a Federation of the British American Provinces, would probably be the legislative union of Nova Scotia, New Brunswick, Prince Edward Island, and Newfoundland. These Provinces have an aggregate population of 822,000 souls,* and an area of 84,353 square miles. The value of

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* The population of Newfoundland, in 1851, was 101,600; in 1857, it was 122,638; at the present time it is probably 140,000. Of New Brunswick, the population, in 1840, was 154,000; in 1851, 193,800. Its present population is estimated at 234,000 souls. The population of Nova Scotia. in 1851, was 276,000; in 1861, 330,857—its rate of increase being in the last ten years within a fraction of 20 per cent.; and at the commencement of 1864, its population may, at the same rate of increase, be estimated at 352 000. The population of Prince Edward Island, in 1851, was 55,000; in 1861, it was 80,856; and it now probably exceed 95,000 souls.

		Area in sq. miles.	Estimated pop. Jan. 1864.
New Brunswick		27,620	235,000
Nova Scotia and the Island of Cape Breton		18,600	352,000
Newfoundland		36,000	140,000
Prince Edward Island		2,133	95,000
Total area		84,353	822,000
Estimated area available for agricultural purposes	52.000	—	—
Upper Canada		140,000	1,520,000
Lower Canada		200,000	1,200,000
Estimated area of the Province available for agricultural settlement	90,000	—	—
Basin of Lake Winnipeg and Valley of the River Athabaska		400,000	15.000
[Exclusive of Indian population (40,000)]			
Estimated area available for agricultural settlement	95,000	—	—
British Columbia and Vancouver's Island		210,000	50,000
[Exclusive of Indian population (60,000)]			
Assumed area suitable for agricultural purposes	30,000	—	—
Total area		1,034,353	3,607,800
Estimated area available for agricultural purposes	267,000	—	—

Or about nine times the area of Great Britain and Ireland. But throwing out what may be called the inferior and desert portion of this immense territory, we find the area of the agricultural portion to be approximately 267,000 square miles, or as large as France, Holland, and Denmark put together, with an aggregate population approaching four millions.

their fisheries alone is $15,000,000 per annum; and they have immense available supplies of timber, iron, and coal, together with more than one thousand miles of sea coast, provided with excellent harbours. The total population of British America at the present moment approaches four millions, and the quantity of land *available for agricultural purposes*, is approximately 267,000 square miles—or more than twice the area of the United Kingdom of Great Britain and Ireland; and equal to France (including Corsica), Belgium, Holland, and Portugal combined.

This portion of the British empire contains within itself all those elements of material wealth which assist in creating populous and powerful nations; and besides these advantages, it possesses unsurpassed facilities for becoming the great commercial highway between the Pacific and the Atlantic. With such resources and possible future, it is neither vain nor premature to consider the expediency of consolidating the interests of the different and virtually independent Governments into which it is now divided, and of securing the speedy occupation and future allegiance of the key-stone of the arch, CENTRAL BRITISH AMERICA, upon which their prospective political and commercial position, as a great Federation, will be mainly dependent.

TESSERÆ CONSULARES.[*]

BY THE REV. JOHN McCAUL, LL.D.,
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THE relics of antiquity, which are known by the designation *tesseræ consulares*, are small oblong pieces of ivory or bone, with four faces,[†] bearing an inscription, a part of which is cut on each of the

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[*] Mommsen, *Corpus Inscriptionum Latinarum*, vol. i. p. 195. Berlin, 1863.
Cardinali, *Diplomi Imperiali*, p. 121. Velletri, 1838.
Morcelli, *Delle tessere degli spettacoli Rom.*, ed. Labus, Milan, 1827.

[†] There is one which has six faces. See Marini, *Atti*, p. 822. It bears the inscription—

PINITVS
ALLEI
SP·K·FEB
TI·CL·CAES·$\overline{\text{II}}$
C·CAEC
COS

faces, so that it is doubtful with which we should begin. These four parts of the inscription are generally—a name in the nominative, always of a man; a name in the genitive, generally of a man; the letters SP. with the day of the month, and the names of the consuls whereby the year is indicated. On some *tesseræ* the month is stated, but not the day; and on some both names are in the nominative. There are also other peculiarities, which may be noticed in the following varieties:

(1)
DIOCLES
LONGIDI
SP·K·SEP
CN·OCT·C·CVR

(2)
AESCINVS
AXSI
SP·A·D·VII·K·A
Q·HOR·Q·MET

(3)
PELOPS
PETILI
SP·ME·QVI
CN·LE·L·PHIL·COS

(4)
MYRTILVS
ATTIAE
SP·III·N·IVN
L·SVLL·L·SVLP

(5)
FLORONIVS
ROMANVS
SP·K·DEC
L·CAN·Q·FABR·COS

(6)
C·NVMITORIVS
NORBANVS
SP·III·K·FEB
A·LIC·Q·CRET·COS

(7)
REPENTINVS
CANINI
SP·N·IAN
SER·COR·L·VIS

(8)
CELER
CLODI
SP·ID·IVL
L·ASPR·A·PLAVT

(9)
PAMPHILVS
SERVILI·M·S
SPE·K·FEB
C·CAES·M·LEP

At first sight it is plain that the names in such inscriptions as (1), (2), (3), (4), (7), (8), and (9), are those of a slave and his master or mistress: in (9) the S, standing for SERVUS, is expressed. It is also plain that the names in (5) and (6) are those of freemen. In (1), (2), (4), (5), (6), (7), (8), and (9), the day of the month is stated, but in (3) only the month. In (1), (5), (7), (8), and (9), the leading divisions of the Roman month—*scil.* Calends, Nones, and Ides—are mentioned; but in (2), (4), and (6) intermediate days. In (2) A.D. (*ante diem*) are given; but in (4) and (6) they are omitted. In (3), (5), and (6), but in none of the others, COS follows the names of the consuls. On further enquiry relative to these peculiarities, we find that of the sixty-two *tesseræ*, which are admitted by the best authorities to be genuine,* only five bear the names of freemen. Three give the month alone, and they differ from the others in this particular, that they were not found in or near Rome, but in other localities.

The letters A.D. are found on the most ancient: the oldest of those on which they are omitted is of the date A.D. (*Anno Domini*) 5. Of the fifty-eight, which state the day of the month, twenty-four give the Calends, twelve the Ides, four the Nones, and eighteen intermediate days. COS does not appear on any, which were found at or near Rome, of a date before 52 B.C., but is common on those that were found there of dates after 8 B.C. The earliest date which is inscribed on any of the *tesseræ* is = 85 B.C., and the latest = 74 A.D.

From these preliminary observations it is evident that no part of these inscriptions presents any difficulty,† so far as the reading of

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* No fewer than twenty-eight, of which four or five are in the British Museum, are regarded as "suspected or false" by Mommsen, either on his own authority or in conjunction with that of Borghesi, Henzen, Hefner, Cardinali, or Olivieri. Borghesi remarks that Ligorius did not forge any *tesseræ*, and that counterfeits were not known before the commencement of the 18th century. Mommsen accepts this statement as generally but not universally true.

† As some of my readers may require aid, I subjoin the readings and translations of the examples, which I have given in p. 428:—

(1)

Diocles	Diocles
Longidii	of Longidius
(servus)	(the slave)
Sp——*Kalendis Septembribus*	—— the 1st of September,
Cneio Octavio Caio Curione	in the consulship of Cneius Octavius and Caius (Scribonius) Curio *i.e.* A. U. C. 678 or B.C. 76.

(2)

Æscinus	Æscinus
Axsii	of Axsius
(servus)	(the slave)
Sp——*ante diem septimum Kalendas Apriles*	—— the 26th of March,
Quinto Hortensio Quinto Metello	in the consulship of Quintus Hortensius and Quintus (Cæcilius) Metellus *i.e.* A. U. C. 685, or B.C. 69.

them is concerned, except the letters SP, or, as it is given in n. (9), SPE.

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(3)

Pelops	Pelops
Petilii	of Petilius
(servus)	(the slave)
Sp——mense Quintili	—— the month of July
Cneio Lentulo Lucio Philippo consulibus	in the consulship of Cneius (Cornelius) Lentulus and Lucius (Marcius) Philippus *i.e.* A. U. C. 698, or B.C. 56.

(4)

Myrtilus	Myrtilus
Atticæ	of Attia
(servus)	(the slave)
Sp——tertio Nonas Junias,	—— the 3rd of June
Lucio Sulla Lucio Sulpicio	in the consulship of Lucius (Cornelius) Sulla (Felix) and Lucius (Servius) Sulpicius (Galba) *i.e.* A. U. C. 786, or A.D. 33.

(5)

Floronius	Floronius
Romanus	Romanus
Sp——Kalendis Decembribus	—— the 1st of December,
Lucio Caninio Quinto Fabricio consulibus	in the consulship of Lucius Caninius and Quintus Fabricius *i.e.* A. U. C. 752, or B.C. 2.

These consuls were *suffecti*: the *ordinarii* were Augustus and M. Plautius Sylvanus.

(6)

Caius Numitorius	Caius Numitorius
Norbanus	Norbanus
Sp——tertio Kalendas Februarias	—— the 30th of January,
Aulo Licinio Quinto Cretico consulibus	in the consulship of Aulus Licinius (Nerva Silanus) and Quintus (Cæcilius Metellus) Creticus *i.e.* A. U. C. 760, or A.D. 7.

(7)

Repentinus	Repentinus
Caninii	of Caninius
(servus)	(the slave)
Sp——Nonis Januariis	—— the 5th of January,
Servio Cornelio Lucio Visellio	in the consulship of Servius Cornelius (Cethegus) and Lucius Visellius (Varro) *i.e.* A. U. C. 777, or A.D. 24.

(8)

Celer	Celer
Clodii	of Clodius
(servus)	(the slave)
Sp——Idibus Juliis	—— the 15th of July
Lucio Asprenate Aulo Plautio	in the consulship of Lucius (Nonius) Asprenas and Aulus Plautius *i.e.* A. U. C. 782, or A.D. 29.

These consuls were *suffecti*: the *ordinarii* were L. Rubellius Geminus and C. Fufius Geminus.

(9)

Pamphilus	Pamphilus
Servilii Marci Servus	of Marcus Servilius the slave
Spe——Kalendis Februariis	—— the 1st of February
Caio Cæsare Marco Lepido	in the consulship of Caius (Julius) Cæsar and Marcus (Æmilius) Lepidus *i. e.* A. U. C. 708, or B.C. 46.

The expansion of these letters, which has been generally adopted by Epigraphists from the 16th century, is SPECTATVS, with reference to gladiators, whence the objects are also called *tesseræ gladiatoriæ.* This view is supported by the consideration that the great majority of the persons mentioned are slaves, but few are freemen, and there are no names of women in the nominative.

The sense, in which this expansion was generally[*] understood, was that the gladiator, to whom the *tessera* was given, was "tried," "approved," and allowed to retire on the specified day of the month in the year indicated by the specified consuls. In support of this interpretation the well-known verses were cited :

> " Spectatum *satis, et donatum jam rude quæris,*
> *Mæcenas, iterum antiquo me includere ludo.*"

Morcelli, *de Stilo*, i. p. 412, suggested, instead of *spectatus*, *spectavit*,[†] on the authority of an inscription given by Tomasini and Fabretti, in which that word appeared on a *tessera, in extenso, scil.* PILOMVSVS·PERELI·SPECTAVIT. The sense in which he understood the word, was—"was a spectator," "took his seat amongst the citizens and looked on." He believed that these *tesseræ* were given to gladiators, who had received not only the *rudis*, but liberty, and that they entitled those who had received them to sit amongst the citizens. The inscriptions would thus be regarded as stating the date of the first occasion on which such gladiators availed themselves of the privilege conferred by the presentation of the *tesseræ.* Another expansion, *spectaculum*, has been proposed by Gori, *Inscrip.* i. 74, but I am unable to conjecture in what sense[*] he understood it. Morcelli, who notices this expansion, dismisses the reading with the expressive phrase—*quod miror*. His own expansion, however,—*spectavit*,—cannot be received, even though a second[†] inscription, in addition to that given in p. 431, may be cited in its favour, for there can be but little doubt that both these inscriptions are forgeries. Besides, we may now assume that the first two syllables of the word are SPECTAT, on the authority of the following inscription, on an unquestionably genuine *tessera*, published for the first time by Mommsen,[‡] p. 201:

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[*] Thus Reinesius, *Syntag.* p. 372, remarks: "*Fulvius Ursinus putabat significari videri, quo anno seu consulatu, mense ac die gladiator spectatus, diu multumque in arte versatus, rude sit ac tessera eburnea donatus, quibus solutum se palæstræ atque arenæ legibus athletam ostenderet.*" Amati, *Giornale Arcad.* 1826, explains *spectatus* thus : "*Le picciole taglie quadrilatere di avorto or di osso erano visibili documenti di morte per essi gladiatori ad altri recata, e almeno di sanguinosa vittoria ottenuta con atterrar l'avversario.*" Tomasini, *de tesseris*, makes the astonishing statement: "*Erat autem rudis tessera quædam eburnea, cui nomen gladiatoris ætate emeriti inscribebatur quam qui accipiebat, is ab omni pugnandi necessitate eximebatur.*" It is scarcely necessary to remark relative to this view, that there is no authority for the notion that the *rudis* was a *tessera.*

[†] Ursatus, *de Notis Romanorum*, remarks: SP. Spectatus. *Pignorius, q'ui,* de Servis, *scribit, hanc notam quæ doctos viros hucusque torsit, nihil aliud* "*Significare, quam, spectavit, ut detur intelligere, conductos fuisse aliquos, veluti ab editore, gladiatores insignes, rude olim donatos, spectandi gratia, non pugnandi.*" Pitiscus, *Lexicon*, in *tessera*, Facciolati, *Lexicon*, in *Specto*, and Orelli, n. 2561, adopt the view of Morcelli. Henzen, n. 6162, seems to prefer *spectatus.* Zell, *Delectus*, p. 60, reads *spectandus.*

MENSE·FEBR·M·TVL·C·ANT·COS·ANCHIAL·SIRTI·L·S·
SPECTAT·NVM.

From this it appears that of the two expansions *spectatus* is the more probable; but even it is not satisfactory, and Mommsen with good reason calls it in question. He objects that the words of Horace by no means prove that *spectatus* was the proper or ordinary term for expressing the fact that a gladiator had fought.[||] *Pugnavit*, he believes, would be much more clear and suitable than *spectatus est*. He also notices the inconsistency of the days named on the *tesseræ* with the days, which we know were fixed for the *ludi gladiatorii* at Rome, *viz*. a.d. xiii. xii. xi. x. k. Apr. To these objections I would add, that there is no notice, so far as I am aware, in any ancient author, of *tesseræ gladiatoriæ*.[§] The designation is a modern invention, accepted and used by those archæologists who read SP as *spectatus,* with reference to gladiators. As the explanation, which has been commonly received, is open to objections and cannot be satisfactorily sustained, I venture to offer a suggestion, which seems to me to give a more probable solution of the difficulty. Previously to stating my own view, I must briefly notice the conjecture, which I have seen somewhere, that these objects were *tesseræ frumentariæ.* On this it seems sufficient to remark, that the forms and inscriptions of those *tesseræ* were not similar, and that such tickets were not given to slaves, as appears from Persius, *Sat.* v. 74: *Libertate opus est: non hac qua quisque Velina Publius emeruit, scabiosum tesserula far Possidet.*

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[*] Muratori, *Nov. Thes.* p. DCXI. n. 2, explains SP. as meaning that the person named informed the people that he had given or intended giving a *spectaculum*.

[†] See Mommsen, *c*. p. 200.

[‡] The account of this is so interesting that I give the words: "*Sero reperi in libro ms. Lanthelmi Romieu Arelatensis scripto a.* 1574, *servatoque hodie Lugduni Bat. inter Voss Germ. Gall. Q*, 1. *Legitur ibi f.* 88 *sic:* Ores ie commence icy à fere mention des Epitaphes d'Arles —— —— et en premier lieu ie veux reciter l'escrit memorable, qui se list clairement en une piece d'ivoire ou plustot de corne de cerf, que i'ay, qui a esté nouvellement trouvée icy a la poincte au bord du Rosne, la quelle est si menue et estroicte, qu'elle n' est pas plus longue, ne plus large, que la moytie du petit doigt de ma main, etant percée à l'un des bouts: ou est faite mention de Ciceron, et de Caius Antonius."

[||] The sense, in which the word was understood by the greater number of those who received it, conveyed more than this, as I have stated in p. 431. Mommsen's objection, however, as to the application of *spectatus* to gladiators is valid in whatever sense the term was taken. Indeed I do not recollect any passage in a Latin author, besides that cited from Horace, in which *spectatus* is used with a reference, direct or indirect, to gladiators.

[§] This designation is used by Maffei, Fabretti, Orsato, Marini, &c. And yet the phrase is, as I have remarked, unsanctioned by ancient authority. There is no passage, with which I am acquainted, that mentions any such object as a *tessera* given as a reward, unless the words *tabulam illico misit* in Suetonius, *Claudius*, c. 21, be taken in this sense, as Morcelli interprets them. His explanation, however, is, in my judgment, very unsatisfactory. He seems to have forgotten the statement in Dio Cassius, lx. 13, relative to the usage of Claudius at these shows:—κήρυξι μὲν ἐλάχιστα ἐχρῆτο, τὰ δὲ δὴ πλείω ἐς σανίδας γράφων διεδήλου. *i.e. Præconibus rarissime usus est ac pleraque* tabulis inscripta *significavit*.

Nor does a reference to any usage amongst the Greeks throw any light on the subject. They had, certainly, in use small pieces of ivory, known as *tesseræ theatrales,* but they are entirely different from those objects called *tesseræ gladiatoriæ* or *consulares.* They generally have on one side the name of a deity or man, with a number in both Greek and Latin, and on the other a head or other design, and were most probably* used as tickets of admission to the theatre, the row being designated by the number, and the block (*cuneus*) being known by the name of the deity or man. Thus:

VII
APHC
Z

in which the seventh row of the *cuneus,* called Mars, is indicated. When I first examined the inscriptions on the *tesseræ consulares,* I had seen only those containing the names of slaves, and was inclined to conjecture that they might have been given to persons of that class as testimonials of approved character. Thus Terence, *Adelphi,* v. 6, 5, *is mihi profecto est servos* spectatus *satis.* On re-examination of the subject two or three years ago, I found the names of freemen also; and observing the frequent mention of the Calends, Nones, and Ides, I was led to think that the *tesseræ* were in some way connected with money. Hence I conjectured that the word was SPECTATOR, in the sense "examiner of money;" and now, perceiving that this conjecture derives support from SPECTAT·

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* See Morcelli, ed. Labus, *De alle tessere,* &c.; Rochette, *Mem. de L'Inst. de France,* xiv. 265; Henzen, *Annal. Inst. arch. Rom.* xx. 273; and Curtius, *Corp. Inscrip. Græc.* iv. 273.

NVM· (*i.e.*, as I read it, *spectator numorum* or *numularius*)* in the recently published Arles inscription, I submit this reading as more probable than any of which I am aware.

Of the use of *specto* and its derivatives in this sense, the following passages afford sufficient evidence: *Ex omni pecunia certis nominibus deductiones fieri solebant, primum pro* spectatione, &c. Cicero, *Verr.* v. 78; *Cape hoc, sis. Quin das? Numi sexcenti heic erunt Probi, numerati; fac sit mulier libera, Atque huc continuo adduce. Jam faxo heic erit. Non, hercle, quoi nunc hoc dem* spectandum, *scio.* Plautus, *Persæ,* iii. 3; *Quum me ipsum noris, quam elegans formarum* spectator *siem.* Terence, *Eunuch,* iii. 6, on which Donatus remarks: "*Spectator, probator, ut pecuniæ* spectatores *dicuntur;*" *Adcipe: heic sunt quinque argenti lectæ numeratæ minæ.* Plautus, *Pseudol,* iv. 7, 50; *Lectum'st: conveniet numerus quantum debui.* Terence, *Phormio,* i. 2, 3, on which Donatus remarks: "Spectatione *lectum est;*" *Veri speciem calles, ne qua subærato mendosum tinniat auro?* Persius, v. 105, on which Kœnig remarks: *Sumptum hoc ab illo hominum genere, quorum erat* probare numos, *quique* spectatores *vel docimastæ vocabantur.* In later times, the provers of gold were called *spectatores,* as we know from Symmachus, *Epist.* iv. 56:—*Nullo jam provincialis auri incremento trutinam* Spectator *inclinat.* In none of our English works on Archæology is there any explanation of either of these terms—*spectatio* or *spectator*—but the necessity for employing persons skilled in distinguishing base from good coin, and the origin of this *spectatio*, are well pointed out in an article by Dr. Schmitz, on *Moneta*, in Smith's "Dictionary of Greek and Roman Antiquities":

> "As long as the Republic herself used pure silver and gold, bad money does not seem to have been coined by any one; but when, in 90 B.C. the tribune Livius Drusus suggested the expediency of mixing the silver which was to be coined with one-eighth of copper, a temptation to forgery was given to the people, and it appears henceforth to have occurred frequently. As early as the year 86 B.C. forgery of money was carried on to such an extent, that no one was sure whether the money he possessed was genuine or false, and the prætor M. Marius Gratidianus saw the necessity of interfering. (Cic. *de off.* iii. 20.) He is said to have discovered a means of testing money and of distinguishing the good from the bad denarii. (Plin. H. N. xxxiii. 46.) In what this means consisted is not clear; but some method of examining silver coins must have been known to the Romans long before this time. (Liv. xxxii, 2.)"

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* The *numularii* did more than tell whether coin was good or base. They seem to have been like our money brokers. Their occupation and position were below those of *argentarii.* In the Theodosian Code, xvi. 4, 5, *servi* and *numularii* are classed together.

Dr. Schmitz's interpretation of the passage in Pliny's Natural History seems to me very doubtful. The words are—"*Miscuit denario triumvir Antonius ferrum. Miscentur æra falsæ monetæ. Alii e pondere subtrahunt, quum sit justum lxxxiv e libris signari. Igitur ars facta denarios probare, tam jucunda lege plebi, ut Mario Gratidiano vicatim totas statuas dicaverit. Ars facta denarios probare* do not appear to me to signify—"a means of testing money and of distinguishing the good from the bad denarii was discovered," for that cannot have been done *lege*, "by a law;" but rather "the testing of denarii was made an art, became a recognised occupation," *i.e.* the law of Gratidianus provided for the appointment or recognition of a certain class, whose business it was to distinguish good and base denarii. It seems probable that this law also had enactments relative to ascertaining the competency of those persons, who were to practise this art, and as to distinguishing them when approved. Thus the origin of *spectatores* may, perhaps, be traced to this law; and it is not unworthy of remark, that the oldest *tessera* of the whole series is of the date, 85 B.C.

It seems not improbable then that these *tesseræ* were carried, or, it may be, hung round the neck, by those who acted as *spectatores*, as badges indicative of their occupation, and that the inscription showed that they were authorized to act as such, having been approved on the stated days, or in the stated months. Thus the frequency of the occurrence of the Calends, Nones, and Ides seems to be satisfactorily accounted for; for these were, as is well known, the settling* days, the principal times for money transactions. But a question presents itself—which may also be asked if we accept the old reading *spectatus* with reference to gladiators—why the days are stated on those *tesseræ*, which were found at or near the city, whilst the three examples of the month alone are on those found in other places, *viz.*, Parma, Modena, and Arles? Mommsen is of opinion that perhaps we should take in these instances the month as used for the Calends of the month—"*fortasse intelligendæ sunt ipsæ kalendæ in tesseris his nescio quomodo præcipuæ.*" Another explanation of this distinction may be given by supposing that these badges or certificates were issued in Rome on any day of the month, on which they were applied for, especially the Calends, Nones, and Ides, being those on which the services of the *spectatores* would be most required ; whilst in the country parts they were issued only once in the month, the day for such issue not being fixed, but left to the discretion of the issuing officers.

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* *Nemo Rabonio molestus est neque* Kalendis *Decembribus neque* Nonis *neque* Idibus. Cicero, *Verr.* ii. 1, 57; *Omnem redegit* Idibus *pecuniam, Quærit* Kalendis *ponere.* Horace, *Epodes*, ii. 69, on which see Orelli.

Still another view may be taken, that these *tesseræ* indicated the time, not from which the persons holding them might act as *spectatores,* but for or during which they were empowered to discharge that duty —in the city for a specified day— in the country for* a specified month.

In addition to the inscriptions of this class which have been already noticed, there is an unique, which Mommsen believed that he he had found on one of the *ollæ ex Vinea S. Cæsarii.* The inscription stands thus:

FELIX·PETIC·SP K FEB
M·CAES·GALIVS

This so closely resembles those found on *tesseræ,* that that distinguished Epigraphist, although well aware that those *ollæ* bore funereal records, attempted to discover the names of the consuls in the second line, and proposed M·CAESO·GAB·COS. *i·e. Marco Cæsonino et Gabinio consulibus, scil.* the Piso and Gabinius of A. U. C. 696. He now, however, p. 212, justly abandons this reading. It is difficult to decide for what SP stands there: the most probable expansions are *Servus Publicus*, and S[E]P for *Sepultus*, the latter of which is preferable.

There is also a singular object, apparently of this class, in the Museum at Paris, as noticed by Chabouillet, *Catalogue des camées et pierres gravées de la Bib. Imp.*, n. 3171. It bears the following inscription:

D·IVNIVS
HERMETVS
SPECT K·MAR.
M LEPID Q CAT

There is reason to suspect that this is a forgery, for the *tessera* is not of ivory or bone but of metal.

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* There is no objection to the Latinity of *mense* in this sense, *viz.* "during."

A POPULAR EXPOSITION OF THE MINERALS AND GEOLOGY OF CANADA.

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(Continued from page 219.)

The Upper Silurian Series:—This subdivision in Canada—as separated from the Middle Silurian series—contains but two groups of strata: the Onondaga formation at the base of the series, and the succeeding Lower Helderberg division; but the latter, as regards the greater part of the Province, is but feebly represented.

The Onondaga Formation:—This division, more commonly known as the "Onondaga Salt, or Gypsiferous, Group," derives its name from the village of Onondaga, near Syracuse, in the State of New York. The abundant brine-wells of that locality belong to the group. In Canada, the Onondaga deposits average in thickness between two and three hundred feet, and consist essentially of thin-bedded dolomites, usually of a yellowish colour, with greenish shales (chiefly argillaceous dolomites), and some associated masses of gypsum. The latter substance, so largely employed as a mineral manure, and in the preparation of *Plaster of Paris* (see PART II.), does not occur in regular beds, but in large lenticular masses, as exhibited in the annexed figure. The dolomitic layers above the gypsum, are generally arched, and more or less fissured; whilst those on which the gypsum rests, retain their normal condition. The disturbance, consequently, by which the upper beds have been affected, was evidently produced by some after cause connected with the presence of the gypsum. The peculiarity was originally explained by assuming the gypsum to have been derived from the surrounding rocks by the gradual action, upon these, of springs containing a certain amount of free sulphuric acid: springs of this kind occurring, at present, at several localities in Western Canada and New York. But it is now regarded by Professor Sterry

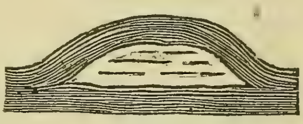

Fig. 226

Hunt as more probably due to the contraction of the gypsum masses having been less than that of the overlying and contemporaneously deposited shale materials, in consequence of which, the latter would gradually settle down and fold themselves around the gypsum. Another view assumes the sulphate of lime to have been originally deposited in the form of *anhydrite*, a closely related mineral but without water of crystallization. The after absorption of water would then cause an increase in bulk, and so produce the bulging and fracturing of the overlying beds.

Fossils are scarcely known in this formation. A few obscure and rare traces of organic forms are all, indeed, that have been recognized in Canadian localities. The Onondaga deposits are in great part of chemical origin, and were evidently accumulated in strongly saline waters, principally by evaporation : facts which go far to explain the absence of organic remains. The only forms of probable occurrence would be certain cyproids or bivalve entomostracans, as species of these, at the present day, inhabit brine solutions in which an active evaporation is going on. Casts of prismatic crystalline masses, however, like that exhibited in figure 214, and others of a flat and square pyramidal or hopper-shaped form, the latter evidently derived from ordinary salt, are of not uncommon occurrence. This would follow naturally from the conditions under which the beds were deposited.

The Onondaga formation (No. 13 in the sketch-map, fig. 249) crosses the Niagara River above and below Grand Island, or a short distance above the Falls, and follows the general outcrop of the Niagara and Guelph formations up to the vicinity of the Saugeen River on Lake Huron. It thus passes through portions of the Counties of Welland, Haldimand, Brant, Oxford, (north-east corner), Waterloo, Perth, and Bruce, but throughout much of this area it is covered by Drift accumulations. On the American side of Lake Huron, the picturesque island of Mackinaw is chiefly made up of Onondaga rocks, and these occur also in places on the adjoining coast of Michigan. Canadian exposures are exhibited chiefly near the village of Waterloo, in Bertie township, on the Niagara River ; along the Grand River between Cayuga and Paris, and higher up the stream near the Don Mills ; at places near Ayton and Newstadt, in the township of Normanby, on the Upper Saugeen ; around Walkerton, on the Saugeen River, in Brant township ; and at various points down the river, more especially at the elbow in the south-west corner of Elderslie township, and on the banks of the stream a little below Paisley. At the mouth of the Saugeen, and on the adjacent coast south of this, the formation is concealed by Drift sands and clay.

The gypsum or "plaster" deposits constitute the most valuable economic material of the Onondaga beds; but some of the dolomitic shales of the formation, as those at Walkerton, furnish also valuable materials for the manufacture of hydraulic cement. The gypsum is principally mined or quarried at Cayuga, Indiana, and York, in the township of Seneca; also at Mount Healy and elsewhere in the adjoining township of Oneida, on the opposite side of the Grand River; in Brantford township; and largely around Paris. The annual amount obtained at present from these localities, is between fourteen and fifteen thousand tons.*

The Lower Helderberg Group.—The group of rocks thus named, is developed somewhat extensively in the vicinity of the Helderberg Mountains and in the eastern part of New York generally, as well as in the more eastern part of Canada south of the St. Lawrence; but it thins out towards the west, and presents merely two or three outlying patches in the neighbourhood of Montreal, and a comparatively narrow strip of slight thickness in Western Canada, between the eastern end of Lake Erie and the township of Cayuga. It may probably extend beyond this latter point along the western limit of the Onondaga zone, up to Lake Huron, but no exposures of its strata have been seen west of that township. This strip, in no place exceeding fifty feet in thickness, consists of the lowest division of the group as subdivided by the New York geologists, or of the equivalents of their "Water-lime Group or Tentaculite Limestone." With us, in Western Canada, it might be called the "Bertie or Cayuga dolomite," as its only known exposures are in those townships; or a still better term would be the *Eurypterus* formation, so named from its principal and characteristic fossil: the *Eurypterus remipes*, a low form of the crustacean class, figured in woodcut 227. In the above townships its strata consist of thin-bedded greyish dolomites, interstratified towards the base with a few brownish shales, and with a brecciated bed composed chiefly of dolomite fragments.

At St. Helen's Island and Round Island, opposite Montreal, on Isle Bizard, and at one or two neighbouring localities, some outlying or small isolated patches of conglomeritic rock, referred to the Lower Helderberg division, have been recognised of late years. Their existence was first pointed out by Dr. Dawson. They are made up of fragments of various rocks, gneiss, Trenton limestone, Utica shale, syenite, &c., cemented together by a paste of greyish dolomite. These conglomerates are regarded as patches of strata once continuous with the Lower Helderberg series of eastern New York, their removal in intervening areas having been effected by denudation. The limestones and shales which at Cape Gaspé, and elsewhere in that region, rest unconformably on the dark shales of the Calciferous or Quebec formation, are likewise referred by Sir William Logan to the Lower Helderberg group. These beds are, at present, known provisionally as the "Upper Gaspé Limestones"—the lower limestones of the Gaspé series, already alluded to as occurring on the Chatte, Rimouski, and other rivers of that district, being referred to the Middle Silurian period. See the remarks on this point, under the Niagara formation, above.

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* The gypsum, as quarried, sells at about $2 the ton. When ground for manure, the cost per ton is about $3.50; and when calcined for plaster, about fifteen or sixteen dollars.

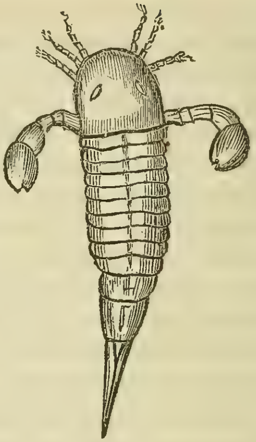

Fig. 227.
Eurypterus remipes (reduced).

Devonian Strata.—The rock formations of Devonian age, occurring in Canada, are restricted to the following subdivisions (here named in ascending order):—(1), The Oriskany Formation; (2), The Corniferous Formation; (3), The Hamilton Formation; and (4), The Portage and Chemung Group. Of these, however, Nos. 1 and 4 are but very slightly developed. It is in the Devonian strata, it will be remembered, (at least as regards this continent) that we find the first traces of vertebrated life and of land vegetation.

The Oriskany Formation.—In Canada the so-called Oriskany beds consist essentially of white or brownish sandstones of both fine and coarse grain, averaging about seven or eight feet in thickness. These rest on a layer of chert or hornstone. The latter contains much iron pyrites; and the bottom beds of the sandstone present here and there a brecciated structure, being chiefly made up of fragments of this chert. Fossils are very abundant, but the greater number appear to be identical with those of the overlying Corniferous formation. This fact, combined with the cherty character of the beds, renders the separation of the two groups little more than a mere arbitrary distinction. Amongst other forms, the following may be enumerated as especially abundant:—*Favosites Gothlandica* (fig. 215), *Zaphrentis prolifica* (fig. 230), *Strophomena rhomboidalis* (fig. 232), *Atrypa reticularis* (fig. 240), *Stricklandia elongata* (fig. 236), *Pentamerus aratus* (fig. 235), and *Calymene Blumenbachii* (fig. 209).

This formation, which is somewhat extensively developed in the State of New York, enters Western Canada in Bertie township (about opposite to Buffalo) and appears to extend as a thin band along the southern edge of the Eurypterus or Onondaga deposits, at least as far as the County of Norfolk; but the only known exposures occur at places in the townships of Bertie, Dunn, North Cayuga, Oneida, and Windham. From the exposure in North Cayuga, a little north of the Talbot road, good millstones have been obtained.*

The Oriskany formation is probably represented in Eastern Canada, according to Sir William Logan, by some of the sandstones of Little Gaspé and that district. A small seam of coal, under two inches in thickness, occurs in these beds, together with numerous carbonized plants. The latter have been described and figured by Dr. Dawson in the *Canadian Naturalist*, vols. V. and VI.

The Corniferous Formation.—This group of strata includes the "Onondaga limestone" and the "Corniferous limestone" of the New York geologists. Its name is derived from the occurrence of nodular masses and layers of chert or hornstone in many of its beds. It is made up essentially of limestones, generally free from magnesia, but often highly bituminous, combined with layers of chert, and with a few beds of calcareous sandstone and an occasional band of bituminous shale. The total thickness of the formation, with us, is apparently under 200 feet, but this is somewhat doubtful. The limestones are exceedingly fossiliferous; and in places (more especially towards the base of the formation) they abound in fragments of crinoids and other organic remains in a silicified condition. The fossils, indeed, are mostly, though not entirely, in this condition throughout the group.

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* These are manufactured by Mr. DeCew, Provincial Land Surveyor, of DeCewsville, near Cayuga, in Haldimand County: from whom, also, interesting suites of fossils, belonging to the formations of that district, may be procured.

They have formed the nuclei, to which, during the consolidation of the strata, much of the cherty matter has been attracted. In some of the silicified corals and brachiopods, petroleum is also found.

A few of the more important organic remains are shown in the annexed figures:—

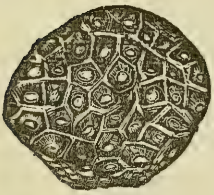

Fig. 228.
Michelinea convexa
(D'Orbigny).

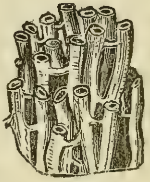

Fig. 229.
Syringopora Maclurei
(Billings).

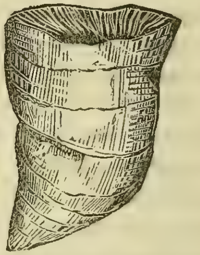

Fig. 230.
Zaphrentis prolifica
(Billings).

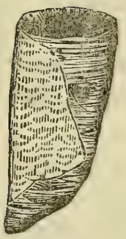

Fig. 231.
Cystiphyllum Senecaense
(Billings).

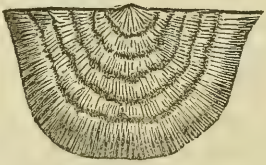

Fig. 232.
Strophomena rhomboidalis
(Wahlenberg).

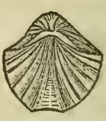

Fig. 233.
Spirifer gregarius
(Hall).

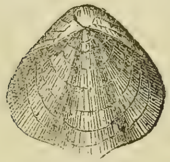

Fig. 234.
Athyris Clara
(Billings).

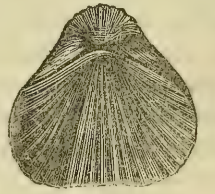

Fig. 235.
Pentamerus aratus
(Conrad).

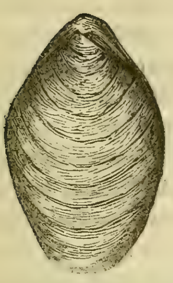

Fig. 236.
Stricklandia elongata
(Billings).

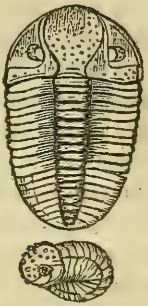

Fig. 237.
Phacops bufo
(Green).

In addition to these forms, *Spirifer mucronatus* (fig. 238), *Spirigera concentrica* (fig. 239), and *Atrypa reticularis* (fig. 240), may also be mentioned as being of common occurrence.

The Corniferous formation (No. 16 in the sketch-map, fig. 249) occupies two extensive areas in Western Canada, although covered and obscured in most places by Drift accumulations. These areas comprise portions of the counties of Welland, Haldimand, Norfolk, Brant, Oxford, Perth, Huron, and Bruce, on the one hand, and parts of Kent, Essex, and Lambton on the other. A comparatively broad tract, occupied by the Hamilton formation, intervenes between these two areas. The latter formation, as shewn some years ago by Sir William Logan, rests in a depression on the summit of a flat but important anticlinal which traverses this western peninsula in a general east and west direction. Exposures of Corniferous strata occur more particularly on or near to the shore of Lake Erie in the townships of Bertie, Humberstone (Rama's Farm, near Port Colborne), Dunn, Rainham, Walpole, Woodhouse, &c.; also in North and South Cayuga; near Woodstock village; largely at St. Mary's; in Carrick township, on a branch of the Maitland, and also in the adjoining township of Brant; at Point Douglas on Lake Huron, and elsewhere along the coast, in the townships of Bruce and Kincardine; further south, near Port Albert, and on the Maitland, near Goderich; and also at the extreme west of the peninsula, as near Amherstburg, on the River Detroit.

Many of these exposures, and more especially that of the last-named locality in Malden township on the Detroit, furnish excellent building materials; but the Corniferous formation is chiefly of importance, in an economic point of view, as the supposed source of the great oil supply of this western region. As the oil-wells in successful operation, however, occur entirely within the central area, across which, as stated above, the Hamilton formation extends, their discussion will be entered into in connexion with the latter series of strata.

In Eastern Canada, the Corniferous formation is undoubtedly represented by a portion of the Gaspé deposits, and probably also by some of the altered strata of the Eastern Townships. The beautiful yellow-veined marbles of Dudswell are thought to be of this age. In Gaspé likewise, as near Douglastown and elsewhere in that district, petroleum springs occur in Devonian strata referrible either to this series, or to the somewhat lower horizon of the Oriskany Formation.

The Hamilton Formation.—The name of this formation must not be confounded with that of Hamilton in Canada: a city situated on strata (the Medina) of a much lower geological horizon. As a misconception of this kind often occurs, it is almost to be regretted that our Provincial Geologist did not in this instance depart from the usual and strictly legitimate plan, and propose for the group in question a Canadian or palæontological name. It might be called appropriately the Lambton or Goniatite formation, the latter type first appearing in the beds of this series. The term "Hamilton," as at present applied to the group, is from the village of that name in Madison County, New York. The American geologists usually subdivide the formation into three groups, distinguished chiefly by lithological characters. The lowest group consists of dark bituminous schists known as the Marcellus shales; the second group, or Hamilton group proper, is made up of argillaceous and other shales or flags, with an interstratified bed of encrinal limestone, and in some places an overlying limestone bed called the Tully limestone; finally, the third or uppermost group is composed of dark shales closely resembling those of the first division, and known as Genesee shales. Some observers separate these latter, however, from the Hamilton formation, and place them in the succeeding Portage group: a view adopted by the Canadian Survey. The Marcellus shales thin out greatly towards the west; and on entering Canada, the formation appears to consist only of the second group; but its junction with the underlying Corniferous strata has not yet been observed. It crosses the counties of Norfolk, Elgin, Kent, Middlesex, Lambton, and the south part of Huron; but is much obscured throughout by overlying Drift deposits.

The best and almost the only known exposures occur in the township of Bosanquet in the north-west corner of the county of Lambton. As there seen, its strata are composed of soft grey calcareous shales, with one or two beds of encrinal limestone. Sir William Logan estimates the total thickness of the formation, with us, at about 300 feet. The shales contain numerous fossils, the most abundant, perhaps, being the four species figured below.*

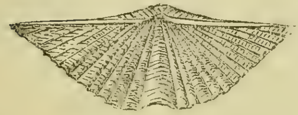

Fig. 238.
Spirifer mucronatus
(Conrad).

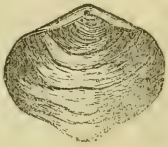

Fig. 239.
Spirigera concentrica
(Von Buch).

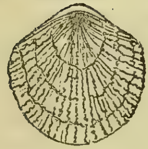

Fig. 240.
Atrypa reticularis
(Linnæus).

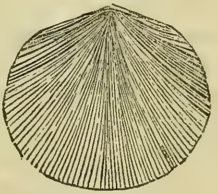

Fig. 241.
Orthis Vanuxemi
(Billings).

In addition to these, several corals and some other brachiopods are of common occurrence; and examples of the trilobite, *Phacops bufo*, fig. 237, are often met with.

Petroleum Springs and Wells.—As stated on a preceding page, the celebrated "oil-wells" of Western Canada are principally situated within the area occupied by the Hamilton shales, although the oil itself, more properly known as petroleum or fluid bitumen, is thought to arise from the underlying Corniferous formation. The existence of natural springs of petroleum in the valley of the Thames, appears to have been known to the Indians long before the clearing of that district. Under the name of "Seneca oil," the petroleum from these sources was employed as a popular remedy for rheumatism, &c., by the early settlers, who are said to have learnt the use of it from the Indians of the locality. In the Geological Report of the Canadian Survey, for 1850, Mr. Murray pointed out the occurrence of several of these so-called "oil springs" in the townships of Mosa and Enniskillen; and in the Report of the succeeding year, attention was called to a deposit in that district of bitumen or mineral tar, arising from the thickening or drying up of petroleum overflows. One of these concreted petroleum deposits occurs in the southern part of Enniskillen, forming two detached portions of about an acre each, and varying in thickness from about a couple of inches to two feet. Another deposit of a similar character, three or four inches in thickness, has been since discovered in the northern part of the township, eight or ten feet beneath the surface of the ground. It occurs in Drift clay above a stratum of gravel. Subsequently to the announcement of the natural springs of this locality, others have been found in the townships of Zone and Orford; and some also near Tilsonburg, in the township of Dereham. These latter lie beyond the limits of the Hamilton formation, or over the Corniferous limestone; and petroleum has been obtained by wells from that rock.

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* These species occur also abundantly in the Corniferous formation; and *Atrypa reticularis* is found as low down as the Clinton group.

In 1857, the idea occurred to Mr. Williams, of Hamilton, C.W., then engaged in the distillation of the solid bitumen of Enniskillen, to bore through the Drift clays of that district into the underlying rock beds, in the hope of striking subterranean reservoirs of the petroleum, such as had been shown to occur in Ohio and Pennsylvania—and his attempt was rewarded by an almost unexpected success. At the present time about one hundred wells or bore-holes have been put down in Enniskillen alone. Many of these were at first "flowing-wells," the petroleum rising above the surface of the ground; but after flowing for some time, the action in the greater number suddenly ceased. Some, however, still continue to flow. Altogether, an immense quantity of petroleum has been obtained from these sources.

The wells in Enniskillen are of two kinds, known respectively as *surface* and *rock* wells. The former pass through the soil and Drift clay to a depth of about 50 or 60 feet into a stratum of gravel immediately above the rock ; whilst the latter are continued into the rock itself, to an average depth of from 50 to 150 feet. The discharge from the wells is accompanied, in many cases, by salt water, and by emissions of inflammable gas. In some of the wells which have ceased to yield petroleum, salt water has taken the place of the rock oil.

The fissures or reservoirs in which the petroleum occurs, are apparently of restricted size, and very irregular in their course. Whilst in some instances, neighbouring wells affect each other, and thus evidently draw their supply from the same immediate source, in other instances, borings put down close to wells in active operation, and carried even to a greater depth, have failed to strike the oil fissure.

The origin of the petroleum is involved in great obscurity. Two views have been suggested in explanation of its occurrence. One of these connects the presence of the rock oil with the great coal deposits of Michigan, or those of Ohio and Pennsylvania. The coal-bearing strata of these districts occupy a much higher geological position than the petroleum-containing beds of Western Canada. The Pennsylvania coal strata are geologically over 10,000 feet above these latter ; and a thickness of 860 feet intervenes between the top of the Hamilton formation and the coal deposits of Michigan. A long interval of time must therefore have elapsed between the deposition of the two series of strata. But the petroleum may have been generated in the Michigan beds at some subsequent epoch, and have been carried along a system of fissures into our Devonian rocks : the two formations, owing to the dip of the strata, occupying very nearly the same topographical elevations. Several facts are opposed, however, to this view. In the first place, no evidence of the occurrence of liquid petroleum amongst the Michigan coal seams has hitherto been obtained, neither are any reservoirs of petroleum known in coal rocks of other localities ; secondly, small quantities of petroleum and of solid bitumen, (a closely allied substance) occur in various strata far below, and topographically far removed from coal deposits ; and thirdly, the direct distance between the rim of the Michigan coal field and the oil district of Enniskillen is at least 80 miles, so that the existence of continnous fissures of communication between the two is not very probable.

The second view regards the rock oil as originating within the strata in which it occurs, by some peculiar decomposition of fucoids or animal remains. Fucoids or sea-weeds, it must be remembered, are the only vegetable matters hitherto discovered amongst the fossilized bodies of our Silurian and Lower Devonian rocks. But if we adopt this view, we must adopt, also, certain other and apparently unwarrantable conclusions. The organic remains of these strata are not more numerous than those of other strata in which not the slightest traces even of petroleum have been found; neither do they present any characters peculiar to themselves and suggestive of oil-forming capabilities. Hence we have to infer the existence in the Devonian seas in which these deposits were laid down, of a vast abundance of soft-bodied animals, or sea-weeds, of a nature altogether unknown: a most gratuitous supposition. The enormous quantity of petroleum yielded by these sources, and by others in the American States and elsewhere, renders the formation of this substance from sea weeds or perishable animal remains in the highest degree improbable.

But are we absolutely driven to the adoption of either of the above views, in order to explain the occurrence of petroleum in our Devonian strata? The question mainly turns upon this: Are we forced to assume with certain chemico-geologists—who refuse all explanations of natural phenomena incapable of being rendered evident by laboratory experiments—that all forms of carbon, and all compounds into which carbon enters (with the sole exception of carbonic acid, and that only in part) are necessarily of organic derivation? With all respect for laboratory investigations, some of which have shed much light on obscure geological problems, it cannot be doubted that this view assumes too much. There are many facts, universally recognized as such, which chemistry is quite unable to explain. The allotropic conditions of certain simple bodies, for instance, carbon amongst the number; the existence of chlorine, oxygen, &c., in the solid state in the greater number of their compounds; the peculiar condition of water in hydrated substances, and so forth. We have the positive fact likewise that carbon exists, as such, in meteoric stones; that it separates often in crystalline scales from molten iron; and that it is present in steel, a fusion-product, also, as sometimes prepared. Why, then, are we debarred from assuming its existence amongst the primary or original components of the earth-mass? During volcanic outbreaks in many parts of the world, petroleum has frequently made its appearance, through fissures on the sea-bed, or around the volcanic vent, as one of the products of the eruption. This was memorably the case in the eruption of Vesuvius in 1861.* The great petroleum springs of Central Asia, which have been flowing for ages also, with those of Zante (mentioned by Herodotus) and others of different localities, lie essentially in areas of volcanic action; and the so-called mud-volcanoes often pour out large quantities of bituminous matter, mixed with other products. It might be argued that in these cases the petroleum is derived from deeply-seated coal beds, but of this we have no proof. And when we consider the fact that small quantities of bitumen and petroleum occur in rocks geologically far older than those of the coal series, we have an equal right to assume that these matters may be generated, without the aid of organic bodies, by unknown chemical action within the crust of the earth, and may be poured out through fissures from time to time, both amongst deposits under process of accumulation, and amongst others already consolidated.† In this manner, I imagine, our petroleum springs of Western Canada have originated. And I would go beyond this, and refer to the same action a leading part in the formation of all bituminous shales, and of coal seams generally. In the latter case, the liquid bitumen or petroleum may be conceived to have flowed into broad marshes, or over low-lying districts, in which an abundant vegetation was under growth. The vegetable matters thus saturated and mixed up with the thickening petroleum, would add their substance to the formation of the coal, and would be chiefly instrumental perhaps in imparting to this its peculiar character. On this view, the formation of bituminous shales by the saturation of the finer kinds of sedimentary matter by petroleum overflows, becomes readily explained; and also the close agreement in character which exists between the shales of the coal measures and those of many Silurian strata. The old view does not explain these points in a satisfactory manner. The petroleum theory likewise obviates the necessity of assuming the growth of an enormous and unparalleled vegetation during the Carboniferous period; and it explains why the vegetation of after periods so rarely yielded coal—the outflows of petroleum having chiefly taken place during the Carboniferous epoch, and only locally at other times.

The Portage and Chemung Group.—The rocks of this group, so largely developed in the peninsula of Michigan and other districts of the American States, occur with us in the form only of a few isolated and inconsiderable patches. These consist of black and highly bituminous shales—the probable equivalents of the "Genesee slates," referred by some observers, as already explained, to the Hamilton formation. The principal locality of these shales is Cape Ipperwash, or Kettle Point, in the township of Bosanquet on Lake Huron; but they occur also nearly twenty miles inland from this point, on a creek near Kingston Mills in the south part of the township of Warwick; and also, still further inland, in the township of Brooke. The shales weather dull-grey, and those of Cape Ipperwash are occasionally coated with a yellow crust of oxalate of iron (see PART II. under "Humboldtine"). They contain large spherical concretions (with radiated internal structure) of carbonate of lime; and also much iron pyrites. In the shales of Kettle Point, likewise, long flattened stems of vegetable forms (mostly referred to the *Calamites inornatus* of Dawson) are of common occurrence; and impressions of fish scales are met with in those of Warwick. The thickness of the exposure at Kettle Point is under fifteen feet; and it is still less than this at the other localities.

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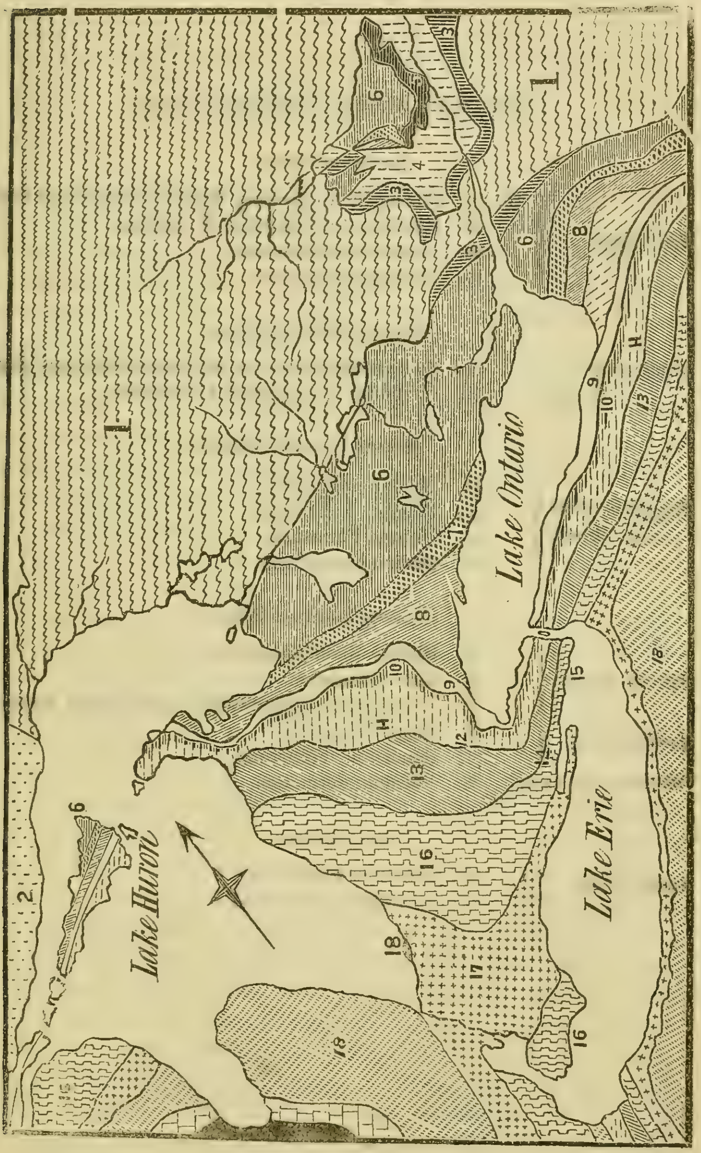
* See *Canadian Journal*, vol. vii, p. 126.

† If the term "unknown chemical action" be here objected to, we may refer, amongst other cases, to that of the diamond: a substance certainly formed by chemical action, but of a kind altogether unknown to us.

Carboniferous Strata.—The Bonaventure Formation.—The only locality at which Carboniferous strata occur in Canada is the south-eastern extremity of Gaspé. Exposures of great thickness range along the Bay of Chaleurs and the coast of Percé, and enter Gaspé Bay. These Carboniferous strata occur consequently, for the greater part, in the district of Bonaventure; and as they make up the entire portion of the island of that name, off Percé, Sir William Logan has bestowed upon them the name of the *Bonaventure Formation.* They consist essentially of conglomerates, associated with red and brown sandstones and some reddish shales. The conglomerates are made up of pebbles of limestone, sandstone, syenite, agate, quartz, and other rock-matters, held together by an arenaceous or partly calcareous cement. Many impressions and casts of vegetable remains occur throughout this formation, but its beds are apparently destitute of coal. They belong to the base of the coal series, proper; and evidently form a portion of the northern rim of the New Brunswick coal field.

The Bonaventure Formation rests unconformably on the Gaspé sandstones and limestones, and dips generally towards the south-east. According to Sir William Logan, it presents a total thickness of about 300 feet.

SKETCH-MAP OF THE GEOLOGICAL FORMATIONS OF WESTERN CANADA.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Lake Ontario
Lake Huron
Lake Erie

Fig. 249.

References to Map on preceding page.

DEVONIAN SERIES:

Erie Group.	No. 18.	Portage and Chemung Group, (Kettle Point Form.)
	17.	Hamilton (or Lambton) Formation.
	16.	Corniferous Formation.
	15.	Oriskany Formation.

UPPER SILURIAN SERIES:

Grand River Group	14.	Eurypterus Formation, or Lower Helderberg Group.
	13.	Onondaga or Gypsiferous Formation.

MIDDLE SILURIAN SERIES:

Niagara or Anticosti Group.	12.	Guelph Formation.
	11.	Niagara Formation.
	10.	Clinton Formation.
	9.	Medina Formation.

LOWER SILURIAN SERIES:

Ontario Group.	8.	Hudson River Formation.
	7.	Utica Formation.
	6.	Trenton (including Bird's Eye and Black River) Fn.
Quebec Group.	5.	Chazy Formation.
	4.	Calciferous Formation.
Potsdam G.(in part.)	3.	Potsdam Formation.

AZOIC SERIES:

Azoic Group.	2.	Huronian Formation.
	1.	Laurentian Formation.

THE POST-TERTIARY DEPOSITS OF CANADA.

Under this term, we include three series of deposits: the Drift or Glacial series, the Post-glacial series, and certain still more recent accumulations. These, though properly distinct, merge so gradually into each other, that no actual lines of demarcation can be drawn between them.

The Drift, or *Glacial Formation* proper, consists of thick beds of clay, sand, and gravel, with *boulders* or transported stones of various kinds and sizes, spread generally over the surface of the country, and extending on this continent to about 40° N. latitude. It does not appear to contain any fossils. Those cited as belonging to it, come properly from Post-glacial deposits. When these Drift materials are removed from the underlying rocks, the surface of the latter (where not in a partial state of disintegration) is generally found to be worn down, so as to present a smooth or even polished condition, and is traversed also by numerous thin lines or grooves, running in a general north and south direction—that is to say from some point between N. W. and N. E., towards the opposite direction in the south. The boulders vary in size from mere pebbles to masses of many tons' weight, and consist of all kinds of rock. In some places they belong to rock-masses of the immediate locality, but far more generally they have been transported by some powerful agency from other and distant sites. With the exception of certain mountainous localities, in which the boulder-courses radiate around central points, these travelled stones have been derived (as regards the northern hemisphere) invariably from northward-lying regions. In Canada, the greater number of boulders consist of gneiss or other varieties of rock belonging to the great Laurentian area described in a preceding part of this Essay; but where limestone or other strata occur in the immediate neighbourhood to the north, these gneissoid boulders are often mixed with pebbles and transported masses derived from the latter beds. Like the surface of the underlying rock, many boulders are smoothed down upon one side, and exhibit, upon this, delicate parallel furrows. Polished and striated rock-surfaces occur, in Canada, on the north shores of Lakes Superior and Huron; on the Blue Mountains, Collingwood township, at an elevation of about 1,500 feet above the sea; in the vicinity of Niagara Falls; the neighbourhoods of Belleville, Kingston, Marmora, Brockville, Ottawa, Montreal, Quebec; and at other localities.* These drift-beds vary in thickness from a mere coating in some spots, to over 100 feet in others. In all places they rest upon denuded surfaces. As a general rule, the lower beds consist of calcareous clays, frequently, if not usually, free from boulders; whilst sand, gravels, and boulders, mixed here and there with seams of clay (mostly free from lime), make up the higher portions of the mass. The conditions under which these various matters appear to have been accumulated, will be referred to presently.

The Post-glacial deposits consist, like those of the true Drift epoch, of beds of clay, sand, and gravel, with here and there a few boulders; and they appear to have been derived in most instances from re-distributed Drift materials. Hence they are often designated by the term of *Modified Drift.* In Canada, east of the gneissoid belt of the upper St. Lawrence, and throughout the New England States of the Northern Union, these Post-glacial deposits contain marine and estuary shells, referrible for the greater part, if not wholly, to species of mollusca now existing in the Gulf of the St. Lawrence, or along the coast from Labrador to Cape Cod. Shells of this kind, mixed with a few other marine types (*Balani*, &c., see PART IV), occur at various heights above the sea-level, extending, as regards Canada, up to about 500 feet. Some of the principal localities of their occurrence, comprise: Kemptville in Oxford Township, Grenville Co. (about 250 ft.); Winchester Township, Dundas Co. (about 300 ft.); Kennyon and Lochiel Townships, Glengarry Co. (270–300 ft.); Fitzroy Township on the Upper Ottawa, Carleton Co. (360 ft.); Green's Creek on the Ottawa, (about 120 ft.); Montreal Mountain (various heights up to nearly 500 feet), and environs of Montreal generally; Upton, Eastern Townships (about 270 ft.); Beauport near Quebec (about 120 ft.); Mouth of the River Gouffre (130–360 ft.); Shore of the River Matanne in Gaspé (about 50 ft.); Banks of the River Métis (130–245 ft.); and terraces of the River Ste. Anne and Rivière du Loup. At Green's Creek on the Ottawa, the shell beds contain, also, examples of the capelin (*Mallotus villosus*) and the lump-sucker (*Cyclostomus lumpus*); and the remains of the northern seal (*Phoca Grœnlandica*), with detached vertebræ of a whale, have been discovered in the Montreal deposits.

Professor Dawson divides the Eastern Post-glacial beds into two series: a comparatively deep-sea deposit, the "Leda clay;" and a shallow-sea or shore-lime deposit, the "Saxicava Sand." Some of the more characteristic fossils of the Leda clay, comprise: *Leda Portlandica,* and *Rhynconella psittacea*; and those of the upper group: *Saxicava rugosa, Mya truncata, Tellina grœnlandica, and Buccinum undatum.*[*]

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* As regards localities in Western Canada, see papers by the author, in *Canadian Journal*: vol. V. p. 41; and vol. VI. p. 221.

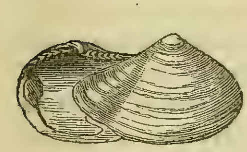

Fig. 242.
Leda Portlandica.

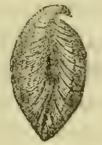

Fig. 243.
Rhynconella psittacea.

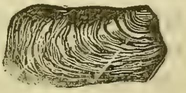

Fig. 244.
Saxicava rugosa.

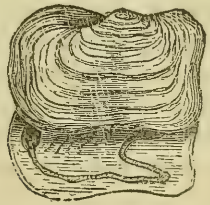

Fig. 245.
Mya truncata.

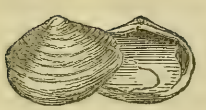

Fig. 246.
Tellina grœnlandica.

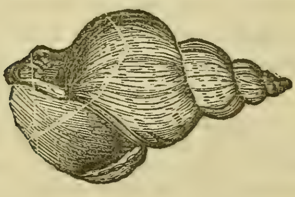

Fig. 247.
Buccinum undatum.

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[*] The reader is referred for figures of the other fossils of these Post-glacial deposits, to valuable papers, by Dr. Dawson, in the *Canadian Naturalist*, vols. II. and IV. Also to an earlier paper on the same subject, by Mr. Billings, in the first volume of that journal.

In Western Canada, or rather in that portion of the Province west of the gneissoid belt that crosses the St. Lawrence at the Thousand Isles, the Post-glacial deposits consist principally of beds of sand, often exhibiting an oblique stratification (see fig. 54 in Part III.) No marine remains of any kind have been detected in these beds. The shells of fresh-water mollusca, on the other hand, occur in them at many localities. These belong to species which still inhabit our lakes and streams, and comprise, more especially, the following genera: *Unio, Cyclas, Amnicola, Valvata, Melania, Planorbis, Limnea*, and *Physa*. Several species of *Helix* accompany these at some localities. Examples of fresh-water deposits of this kind, formed by causes no longer in action where such deposits now occur, have been recognized in the vicinities of Collingwood and Owen Sound; Angus station on the Northern Railway; Barrie, Orillia, Paris, Brantford, Toronto, Belleville, and other places, at various elevations from 30 or 40 to over 500 feet above Lake Ontario—the present surface of the latter being 232 feet above the sea. Fresh-water shells occur also in Post-glacial deposits around Niagara Falls, where, as pointed out by Sir Charles Lyell, many years ago, they evidently indicate the former bed of the Niagara River. It is only, however, within the last two or three years, that the occurrence of these shells throughout the lake area generally, has been definitely ascertained, and the true character of the beds in which they occur correctly shewn.* As the shells in question occur all over this region, and at various heights above the existing levels of the lakes—and as they could not have been drifted into their present positions by freshets, or left there, viewed collectively, by the drying up of ponds, lowering of streams, or other causes—they appear to indicate incontestibly the former union of our great lake-waters, and the consequent extension of these into a vast, inland, fresh-water sea. The barrier that kept up these waters on the east —perhaps a glacier or ice-stream, see below—was undoubtedly situated along the gneissoid belt of the Upper St. Lawrence: the line, it will be remembered, which separates the eastern or marine deposits of this period from those of lacustrine origin. In this connexion, it is interesting to observe that in the township of Pakenham (as discovered by Andrew Dickson, Esq.,) and also in that of Augusta, both immediately adjacent to this gneissoid belt, a few fresh-water types have been found in conjunction with shells of *Tellina Grœnlandica*, (fig. 246), a marine or brackish-water species. The destruction of this barrier—whether of ice or rock—accompanied probably, and perhaps occasioned, by a gradual and periodically-interrupted depression of the eastern country, eventually lowered the waters to their present levels, and caused the formation, by denuding action, of the various ridges and terraces which occur so prominently throughout the lake districts. Those north of Toronto, described as *ridges* by Sir Charles Lyell, and thought by him to be of marine origin, are really a succession of *terraces* rising one above another up to a height of about 760 feet above the present surface of Lake Ontario, and then successively descending towards Lake Simcoe and Georgian Bay—their abrupt or escarped faces being always in the direction of the nearest lake.

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* The first publication on this subject was by Robert Bell, of the Geological Survey of Canada, in the *Canadian Naturalist* for February, 1861. This was followed by a more extended article by the author of this work (who had previously communicated some of his observations to Mr. Bell), read before the *Canadian Institute* in March, 1861, and published in the *Canadian Journal*, vol. vi., p. 221, and in the *Philosophical Magazine* for July of that year. In this paper, the former union of our lake waters, and the lacustrine origin of the terraces north of Toronto, &c., was first maintained. A succeeding paper by the author (*Canadian Journal*, November, 1861, vol. vi., p. 497), described a remarkable locality—first made known to him by one of his students, Mr. A. E. Williamson, of Toronto—in which unios and other fresh-water types occur in great abundance, near the Nottawasaga River, between Lake Simcoe and Georgian Bay.

The mollusca of this region during the Post-glacial period, appear to have been throughout identical with those of our present lakes and rivers; and most of the mammalia were of the same genera and species as those which now inhabit Canada. Of this latter class, the more common remains comprise the jaws and other parts of the common beaver (*Castor* fiber); the horns and bones of the Wapiti (*Elaphus Canadensis**); and the teeth and skull of the black bear (*Ursus Americanus*). Two at least, however, of the mammals that roamed over the shores of the great lake region during the period in question, are extinct. These are the Mammoth, an extinct species of Elephant, (*Elephas primigenius*); and the Mastodon (*M. Ohioticus?*). Their remains, hitherto found with us, mostly of detached molar teeth (fig. 248); but examples, more or less entire, of the skull and tusks have also been discovered. The sediments in which these occur,

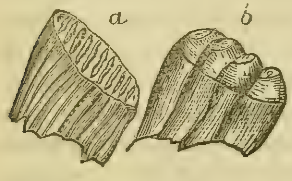

Fig. 248.

a—Molar tooth of *Elephas primigenius.*
b—Molar tooth of *Mastodon Ohioticus.*

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* The Wapiti, although at one time common throughout Canada, is now only to be found in the extreme northern and north-western regions. and will probably become extinct at no distant day.

appear to be of the same age and character as those which at Amiens, Abbeville, Creil, Suffolk, Bedford, and elsewhere, contain flint implements of rude manufacture, mixed with the remains of the mammoth and other types, both living and extinct. The arrow-heads and other stone implements so constantly found in our Canadian superficial deposits, are of a much less primitive character, however, and belong in all probability to a comparatively recent date.

Conditions under which the Drift amd Post-glacial deposits were accumulated.—It is now universally admitted that the various deposits of the Drift, and immediately succeeding period, were accumulated under conditions more or less resembling those which at present prevail in Arctic latitudes. This conclusion is based chiefly on the following facts:—(1). The resemblance of the polished, rounded, and striated surface of the rocks beneath the Drift, to the surface-rocks of Alpine regions in which glaciers prevail, or to those which in higher latitudes have been subjected to glacial action generally. (2.) The greater development and extension of glaciers in these regions, during the interval between the close of the Cainozoic period and the commencement of the existing epoch, properly so-called. (3.) The evident signs of the occurrence of ancient glaciers in lower and more southern districts during the same period. (4.) The apparent impossibility of any other agency than that of ice to have effected the transportation of the numerous boulders scattered throughout Drift-covered regions: many of these boulders, including some of large size, having been carried across lakes, seas, ravines, and other obstacles, to far distant localities. And (5), the general arctic or northern character of the mollusca, &c., found in the modified drift or Post-glacial deposits of various countries.

The fossils which occur in Cainozoic strata, prove clearly the prevalence of a warm, if not of a tropical climate, throughout the period during which these strata were deposited. Towards the close of the Cainozoic Age, however, the relative levels of land and water, throughout all the more northern and extreme southern portions of the globe, appear to have undergone great though gradual changes, during which, a period of increasing cold came slowly on, covering all the more elevated districts with enormous glaciers, filling the sea with floating icebergs, and compelling a general southerly migration of such life-forms as were able, by this or other means, to resist its destructive influence. The greater part of Canada must certainly have been submerged beneath the sea, during a portion at least of this period. The polishing and striation of the rocks may have been occasioned in part by glaciers, and in part by stranded icebergs; but the transportation of the boulders from the northern districts, southwards, must have been chiefly effected by the agency of the latter: just as at the present day, large masses of granitic and other rocks are dropped over the bed of the Atlantic by the melting of the icebergs on which they travel from the north. It should be mentioned that, as a general rule, these icebergs are nothing more than fragments detached from the extremities of arctic glaciers, where the latter reach the level of the sea. The stones brought down by these enormous ice-rivers, or broken off their rocky shores, collect in large heaps at their lower extremities, and many are thus floated off by the detached bergs, and conveyed over broad oceanic spaces to distant and more southern spots. That the country east of the gneissoid belt of the Upper St. Lawrence was beneath the sea to a depth of at least 500 feet at one period of this glacial epoch, is shown by the numerous deposits containing marine and estuary fossils, which occur, as explained above, throughout that area and the adjoining New England States. The same thing is proved also for both portions of the province, by the thick masses of drift clay, &c., which could only have been accumulated under water. As regards Western Canada—and this may probably apply to eastern districts likewise—a gradual submersion of the Palæozoic or more southern portion must first have taken place, since the lower clays are highly calcareous, and are evidently derived from the Silurian and Devonian strata immediately beneath or closely adjacent to their areas of deposition. The depression still continuing, the higher lands and gneissoid strata of the north would be brought within the influence of the waves, and thus the sands, gravels, and boulders of the Upper Drift deposits, would be gradually accumulated. A re-sorting of these materials must have occurred to some extent during the subsequent elevation of the country, producing, in part, the various post-glacial deposits; although in the western region, most of these latter must have been formed by the great lake-waters whic extended over this area, as described on a preceding page, after the final elevation of the land. The cold of the Drift period, with its accompanying phenomena, came on gradually, and as gradually diminished in intensity; or, in other words, these glacial manifestations shrunk back slowly, after a certain lapse of time, to within the higher latitudes and Alpine elevations in which they still prevail. No strong or abrupt lines of demarcation can thus be drawn between the close of the Cainozoic Age and the dawn of the existing state of things. The one period merged slowly into the other; and certain life-forms, indeed, appear to have existed throughout all the changes which occasioned and accompanied the general deposition of the Drift.

Recent Deposits :—These comprise various formations, of limited thickness and extent, produced by causes now, or recently, in action at the localities in which these deposits occur. The principal consist of: Shell marl, calcareous tufa, bog iron ore, ochres, and peat. *Shell marl* is a soft calcareous deposit made up largely of the minute shells of certain species of planorbis, cyclas, and other fresh-water mollusks. It occurs at the bottom of almost all our lakes, ponds, and swamps; and sometimes forms near the margin of these, a bed of several feet in thickness. This lies usually at a short depth beneath the surface of the ground. It shows the former extension of the pond or swamp near which it is met with. Several specimens, examined by the writer, contained nothing but carbonate of lime mixed with a little sand; but some are said to contain phosphate of lime. The substance on exposure to the atmosphere becomes about as hard as ordinary chalk.

Calcareous tufa is a deposit of carbonate of lime on moss, twigs stones, &c., and is of very common occurrence in many of our smaller streams. Good specimens of a solid structure, capable of receiving a fine polish, are produced by some of the springs which issue from crevices in the Niagara escarpment, as at places near Hamilton, Rockwood, Falls of Noisy River, and other localities along the line of country through which the escarpment runs. A large deposit occurs also on the Beaver River, in the townships of Euphrasia and Artemisia. See under the "Niagara Formation," above.

Bog Iron Ore (see Part II.) is a hydrated sesquioxide of iron, a variety of Brown Iron Ore or Limonite. It arises from the decomposition of iron pyrites and other ferruginous substances in rocks and soils, and the after solution of the oxide of iron, thus formed, by water containing free carbonic acid or organic acids. The iron compounds dissolved by this agency, and carried into swamps and other low-lying places, are there deposited, and are subsequently converted into hydrated sesquioxide. Patches of this kind are also occasionally found on hill tops and sides, by deposition from springs containing ferruginous matter. This bog ore occurs in small quantities in numerous localities throughout the Province; but largely in Norfolk County, C. W., and along the north side of the St. Lawrence, especially in the Three Rivers District, and in the counties of Vaudreuil and Bellechasse, Canada East. The iron ochres, generally associated with the bog ore, have a similar origin (see descriptions of these, in PART II.) The red ochre is anhydrous, but the brown and yellow varieties contain a certain amount of water, usually about 20 per cent.

Economic Materials of the Post-Tertiary Deposits:—These comprise, *Gold, Bog Iron Ore, Ochres, Brick Clay, Shell Marl, Moulding Sand*, and *Peat*.

Gold:—Native gold in fine grains, including here and there a small nugget, occurs in the Post-Tertiary sands of the metamorphic region south of the St. Lawrence: or throughout the area lying between the River Richelieu and the Gaspé peninsula; and more especially along the valleys of the St. Francis, Chaudière, Rivière des Plantes, Etchemin, and Rivière des Loups. (See under "Native Gold," in PART II., *B*. 1.)

Bog Iron Ore:—The principal localities of this substance are given above. The ore, at present, is only melted at the Radnor Furnaces, Batiscan, C. E. The neighbouring furnaces of St. Maurice, after continuing in operation for over a century, went out of blast a few years ago.

Ochres:—These are capable of extensive use as paint materials. A yellow variety, becoming brown and red on ignition, occurs abundantly in the county of Middlesex, and also at Sydenham and in the township of Nottawasaga, in Canada West. Red, brown, yellow, purple, and greenish-black ochres occur likewise in workable quantities near the mouth of the Ste. Anne River, and in the seigniories of the Cap de la Madelaine and Pointe du Lac, in Canada East. Also in the Eastern Townships. The black ochres contain a considerable quantity of peroxide of manganese.

Brick Clay:—Clays suitable for bricks and tiles, occur very generally throughout the Province. White or yellow bricks are largely manufactured in the neighbourhoods of London, Hanover, Toronto, Cobourg, Peterborough, &c. Red bricks at Walkerton, Sydenham, Toronto, Montreal, St. Jean (Lobinière), and many other places. Manufactories of drain tiles are in extensive operation at Treadwell village, on the Ottawa, and in the vicinity of Quebec.

Shell Marl :—This substance, described above, is much employed as a manure, and occasionally also as a whiting or wash-material. It occurs, more or less, all over the Province, but has been worked more especially, in the townships of Bentinck, Carrick, Brantford, King, W. Gwillimbury, Scarborough, Thurlow, Sheffield, Olden, Nepean, and W. Hawkesbury, in Canada West; and near Montreal, &c., in Canada East.

Sand for Moulding :—Good sand for this purpose, has been obtained from the neighbourhood of Dundas, and also at Sydenham (Owen Sound.)

Peat :—Large deposits of this useful substance are known to occur in many parts of the Province, but hitherto, on account of the abundance of wood, they have been generally neglected. Some of the more important localities comprise: Longueuil, opposite Montreal, and many places along the south shore of the St. Lawrence, between that point and the Rivière du Loup (Sir W. Logan). Also La Valtrie, and the seigniory of Cap de la Madelaine, on the north shore. The explorations of the Geological Survey have made known, likewise, a large peat area on the south side of the Island of Anticosti. In Western Canada, peat occurs chiefly in the townships of Plantaganet, Clarence, Cumberland, Gloster, Goulbourne, and Westmeeath, in the Ottawa region. Also in the townships of Humberstone and Wainfleet, on Lake Erie.

⁂ The conclusion of this Essay, embracing a general summary of Canadian Geology, will appear in the next number of the Journal.

THE STRUTHIONIDAE: THE EXTENT AND DIVISIONS OF THE FAMILY WITH ITS SYSTEMATIC POSITION AND RELATIONS.

BY REV. WILLIAM HINCKS, F.L.S., ETC.,
PROFESSOR OF NATURAL HISTORY IN UNIVERSITY COLLEGE, TORONTO.

Having on a former occasion laid before the Institute a scheme for an improved arrangement of Birds founded on principles which I believe to be applicable to the whole animal kingdom, and having afterwards, on occasion of the exhibition of an interesting specimen, attempted to illustrate the application of my principles to one family throughout its details, I now propose in a few occasional papers to examine the true position and relations of some other families, especially where there exist acknowledged difficulties or where my judgment, after giving all the consideration I could to the subject, differs from that of the writers upon whom 1 usually most rely, and whose opinions seem to me deserving of the highest respect. This evening I have to offer a note on the family Struthionidae—the Ostrich tribe—which some have referred to the Rasores (poultry and game birds), others to the Grallatores (stilted or wading birds), whilst many have considered them as entitled to form an Order of themselves, which has been called Struthiones by some, by others Cursores (or running birds). I would endeavour to arrive at a rational and satisfactory settlement of this controversy, marking how the system I adopt removes the chief difficulty; and I would also examine the extent of the family *Struthionidae* and the sub-families of which it is made up, suggesting some affinities not hitherto noted which seem to me not a little interesting, and which harmonize beautifully with the system of a set of different developments of a common type, each of which is analogous with one of the co-ordinate types forming the larger groups, of which the whole family is one of the members.

The beak, the general habits and the nidification of the Ostrich and its allies remind us so strongly of the Rasorial birds, that we see at once that the reference of them to the Grallatores depends entirely on the length of their legs, the great strength of which is, however, somewhat unlike the Waders generally. I am disposed to conclude that those who have arranged the Struthionidae among the Rasores have been guided by real and important analogies; that those who have placed them among the Grallatores have attached undue importance to a single character which really only indicates the position of this in reference to the other families of Rasores; and those who have elevated this group to the rank of one of their great orders of Birds have chiefly manifested their hesitation between the other two views, by taking a sort of intermediate position. A slight view of the limits and genuine members of the Rasorial order may, perhaps, set the subject in a clearer light.

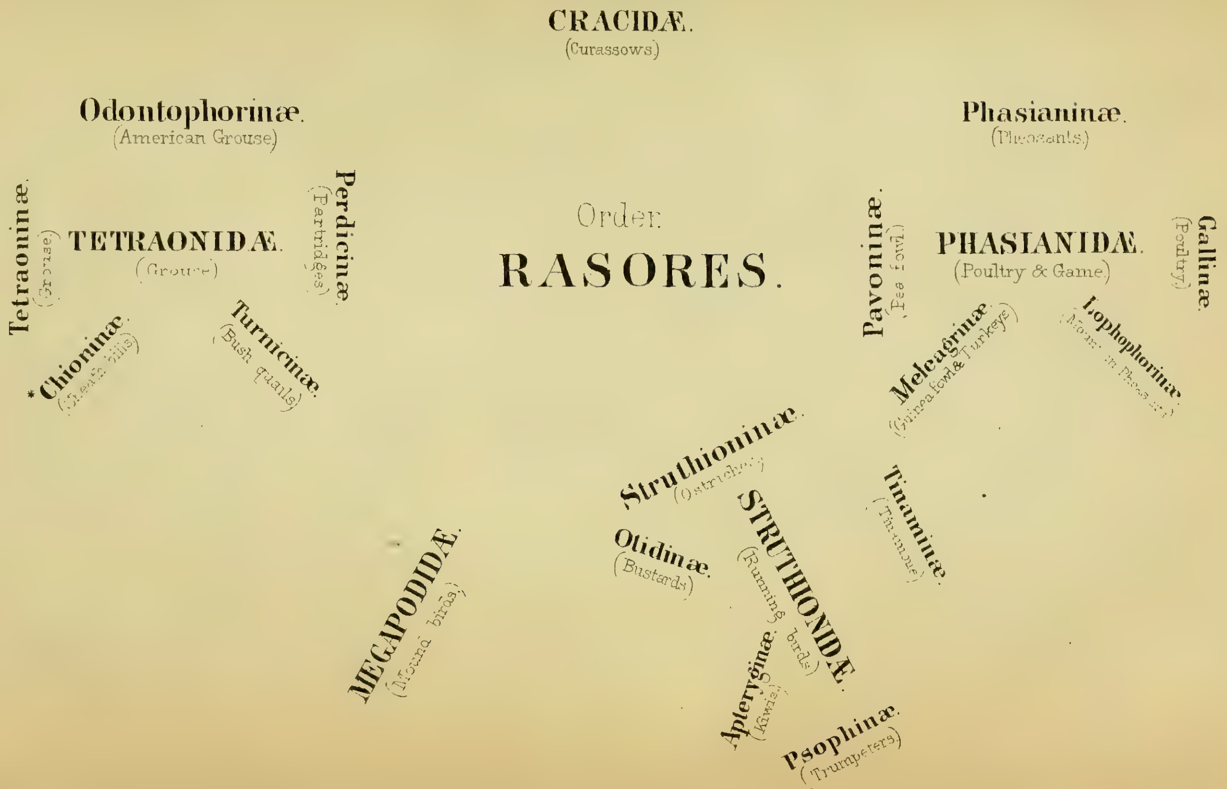
It is well known that by many high authorities the pigeons (*Columbidae*) are counted amongst Rasorial birds, and, without doubt, they have very striking Rasorial characters in the figure of the beak, the cere, and the kind of food, as well as the general mode of feeding; but on the other hand the powers of flight, the feet with the hind toe on the same level as the others, and above all the monogamous character, and the helpless condition of the few young ones, so strongly mark them as belonging to the Insessorial order that the just conclusion is that they represent the specially Rasorial tendency among the hard-billed or *Conirostral* Insessores. There remain among the Rasores the families of *Tetraonidae*, the Grouse; *Cracidae* the Curasows; *Phasianidae* the pheasants and Poultry; *Struthionidae* according to the opinion I have maintained, and *Megapodidae* a singular and little-known Australian family, without mentioning the *Sheathbills*, which I regard as, probably, (at least if they are at all Rasorial birds) a special form of Tetraonidae, or the Tinamous a very interesting South American group which seem to me to be a semi-arboreal form of Struthionidae, and which I therefore reject from among the leading families of the order. It is probable that *Tetraonidae* stand first among the Rasorial birds, as the most complete development of the type; *Cracidae*, with their arboreal habits, may be placed next; *Phasianidae* naturally follow, as the peculiarly typical or specially Rasorial group; *Struthionidae* I consider as occupying the position analogous with that of the order Grallatores in the larger circle; and I have no hesitation in regarding *Megapodidae* as the lowest family in the order. In the accompanying tabular view I give the sub-families in the three best known and most numerous groups, leaving the others for the present, as either being such small families, or our knowledge of them so imperfect, that nothing satisfactory could be accomplished in respect to them.

The family Struthionidae is distinguished by a more or less complete mixture of the long legs and neck of the Grallatores, with the usual Rasorial characters, the birds being generally above the medium size and deficient in power of flight, which in some cases is entirely wanting. We could not precisely define Struthionidae by any one or two characters, (those generally given, as the extremely short wings and rounded sternum, being peculiar to the typical sub-family STRUTHIONINAE), but birds coming near the boundary, between Rasores and Grallatores, in which notwithstanding usual marks of the latter division, the characteristics of the former seem, on the whole, to predominate, may be safely referred to this family. Dr. Geo. Gray, making the single family a distinct order of birds under the name STRUTHIONES, assigns to it three sub-families *Struthioninae, Apteryginae* and *Otidinae*, the bustards. The latter indeed are not destitute of power of flight, but they possess it in a moderate degree with a generally Rasorial structure, and considerable length of neck and legs. Their greater length and power of wing than any others in the tribe with the depressed and feeble beak of the most typical species will mark their position as the Fissirostral type of the family. If we inquire what other families of birds may be suspected of near affinity with these, that we may mark the limits of the family satisfactorily, a slight acquaintance with descriptive Ornithology will suggest two as proper subjects for examination,—first, the Tinamous; secondly, the Trumpeters. The Tinamous consist of a group of three or four genera, with but few species inhabiting the woods and plains of South America, considered as decidedly Rasorial, yet so distinct as to have been treated as a separate family, though in numbers so few that they would more naturally form a sub-family. They are remarkable for short rounded wings, very moderate powers of flight and great strength in running. Some have the hallux, or hind toe, entirely wanting, others remarkably small; some of them are known to roost in the low branches of trees, near the roots of which they lay their eggs. From their characters and habits Dr. G. Gray places them as *the last* family of Rasores immediately adjoining Struthiones. Considering the latter also as a Rasorial family, and expecting its sub-families to display varying analogies, I rank the *Tinaminae* as the lighter and more arboreal form of STRUTHIONIDAE, the peculiar port of which they strikingly manifest, their sternum, though not rounded or deprived of its ridge, as in Struthioninae, is very peculiar, and quite inconsistent with powers of flight. Their comparatively small size might seem an objection to their introduction into this family, but only indicates their representation of the arboreal or most active type, the special character of the class Birds, whose prevailing tendency is to small size; and I cannot but think their relation quite as obvious as that of *Otidinae*, which, nevertheless, I am so far from questioning, that I believe it to be established on the soundest principles. Latham, like Buffon, placed the Trumpeters (*Psophinae*) among the Rasores. More recent naturalists have combined them with Grallatores, and according to Dr. G. Gray, they form (as being nearest to the Rasorial structure) the first sub-family of *Ardeidae*, the Herons. Their beaks and plumage resemble Rasores, as well as their food and habits. They are easily domesticated, and their flesh is excellent food. Their power of flight is very small, but they run swiftly. The editor (we believe Mr. Blythe) of that part of Orr & Co.'s edition of Cuvier's Animal Kingdom, thus comments on the station at the head of the Cranes which his author had assigned to the Agami (*Psophia*) :—"The location of this very singular species among the Cranes is by no means satisfactory; but we do not know that it can be placed to greater advantage elsewhere. Its port resembles that of the Struthious birds; and the configuration of the sternum is unique, not even approaching any other group. Upon the whole, we conceive that it is as nearly allied to the Tinamous which inhabit the same region, as to any other known genus, and would prefer to detach it in a more marked manner from the Cranes." This is important independent testimony, and we need only add that the peculiar figure of the sternum, is, like that of the Tinamou, inconsistent with power of flight. The position of Apteryx, a most extraordinary New Zealand bird, as the type of a sub-family of Struthionidae, seems to be conceded, and its long narrow beak, with the nostrils at its extremity, is so especially Tenuirostral that there can be little doubt about its fittest place, though its entirely suppressed wings and hair like feathers might seem to mark it as last in the circle, because lowest in development—a conclusion, however, to which the consideration of the Emeu and Cassowary, which belong to the first sub-family, is opposed. We have now, therefore, every one of the tendencies of development duly represented in this family, and together forming a complete natural group of very distinct aspect connecting the Rasores with the Grallatores, and representing the latter amongst the former, to which as an order this natural group seems to me manifestly to belong.

NOTE TO DIAGRAM OPPOSITE.

*We have mentioned a reasonable doubt whether the Sheath-bills are truly Rasorial: should this doubt be confirmed, we suggest *Pteroclinae* the sand-grouse, remarkable for their long pointed wings and power of flight, but which, in the above scheme, are incorporated with *Perdicinae*, as occupying this station. Some doubt also attends *Odontophorinae* which can scarcely be well separated from *Tetraoninae*. Perhaps the true combination for this position is formed from the smallest birds of the tribe, popularly called Quails, and including the Genera Ortyx, Cryptonyx, and Coturnix. We need a more intimate acquaintance with some of these birds, before the family can be satisfactorily arranged.

Tabular View of the Families of RASORES.


CRACIDÆ.
(Curassows)
Odontophorinæ.
(American Grouse)
Phasianinæ.
(Pheasants)
Tetraoninæ.
(Grouse)
TETRAONIDÆ.
(Grouse)
Perdicinæ.
(Partridges)
Order
RASORES.
Pavoninæ.
(Pea fowl)
PHASIANIDÆ.
(Poultry & Game)
Gallinæ.
(Poultry)
*Chioninæ.
(Sheath bills)
Turnicinæ.
(Bush quails)
Meleagrinæ.
(Guinea fowl & Turkeys)
Lophophorinæ.
(Monaul Pheasants)
Struthioninæ.
(Ostriches)
Tinaminæ.
(Tinamous)
Otidinæ.
(Bustards)
STRUTHIONIDÆ.
(Running birds)
MEGAPODIDÆ.
(Mound birds)
Apteryginæ.
(Kiwis)
Psophinæ.
(Trumpeters)

W. C. Chewett & Co. Lith. Toronto.

EDITORIAL.

Prehistoric Man: Researches into the Origin of Civilization in the Old and the New World. By Daniel Wilson, LL.D., Professor of History and English Literature in University College, Toronto; Author of the "Archæology and Prehistoric Annals of Scotland," etc. In two volumes. Cambridge and London: Macmillan and Co.

Britanno-Roman Inscriptions, with Critical Notes. By the Rev. John McCaul, LL.D., President of University College, Toronto, &c. Toronto: Henry Rowsell. London: Longmans.

Explorations in Labrador. By Henry Y. Hind, M.A., Professor of Chemistry in Trinity College, Toronto. Two volumes. 8vo. London: Longmans.

Air-Breathers of the Coal Period: A Descriptive Account of the Remains of Land Animals found in the Coal Formation of Nova Scotia, with Remarks on their bearing on Theories of the Formation of Coal, and of the Origin of Species. By J. W. Dawson, LL.D., F.R.S., F.G.S, etc., Principal of McGill University. Montreal: Dawson Bros.

Abstracts of Magnetical Observations made at the Magnetical Observatory, Toronto, Canada West, during the Years 1856 *to* 1862, *inclusive, and during parts of the Years* 1853, 1854, *and* 1855. Toronto: Printed by Lovell and Gibson.

Prehistoric Annals of Scotland. By Daniel Wilson, LL.D., Professor of History and English Literature in University College, Toronto; Author of "Prehistoric Man," etc. Second edition, revised, and nearly re-written. With numerous illustrations. 2 vols. 8vo. London and Cambridge: Macmillan and Co.

The evidence of literary and scientific activity afforded by the above list of works cannot fail to be gratifying to Canadians, and, in particular, to the members of the Canadian Institute, to which Society the authors without exception belong, and at whose meetings not a few of the investigations now embodied in these works were originally communicated. The peculiar connection in which these authors mostly stand with this *Journal*, either in being on its editorial staff or being members of Council in the Society, renders it inexpedient to give any detailed criticism or general review of their productions; that task must be delegated to other pens less liable to be influenced by partial feelings than those of the writers of this *Journal*. Nor have such in abundance been wanting among the influential critics of the Old World; and to them, whether for praise or blame, our readers must perforce be referred. We may, however, with propriety notice one small fact, namely, that the volume of Observations made at our Provincial Observatory since the date of its transfer, has been published *before* the completion of the issue of the Observations, made previously to that date, which has been for ten years preparing under the care of the Imperial authorities.

Neither should we omit to notice in further evidence of Canadian enterprise, the publication of a Literary Monthly Journal* under the editorship (it is understood) of a member of the Council of the Institute, to which we offer our best wishes for a prosperous career.

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* *The British American; A Monthly Magazine devoted to Literature, Science, and Art.* Toronto: Rollo and Adam.

CANADIAN INSTITUTE.

PROCEEDINGS AT THE GENERAL MEETINGS.

ANNUAL GENERAL MEETING.—20*th December*, 1862.

Hon. G. W. Allan, M.L.C., in the Chair.

I. The report of the Council for the year 1861-62 was read and adopted, on motion of S. B. Harman Esq., seconded by Doctor Ogden.

II. A ballot having been taken for officers of the Institute, for the ensuing year, the following gentlemen were declared duly elected.

President	Rev. J McCaul, LL.D., President University College.
First Vice-President	T. C. Keefer Esq., C.E.
2nd do	Sandford Fleming Esq., C.E.
3rd do	Rev. Prof. G. P. Young, M.A.
Recording Secretary	P. Freeland, Esq.
Corresponding do	B. R. Morris Esq., M.D.
Treasurer	D. Crawford, Esq
Curator	Prof. H. Y. Hind, M.A., F.R.G.S.
Librarian	Rev. H. Scadding, D.D.
Council	Prof. D. Wilson, LL.D.
do	Prof. H. H. Croft, D.C.L.
do	Prof. Rev. W. Hincks, F.L.S.
do	Prof. Rev. G. C. Irving, M.A.
do	U. Ogden, Esq., M.D.
do	T. Moss, Esq., M.A.

III. *The following Paper was read:*

By Prof. H. Y. Hind, M.A. "On Vegetable Parchment, its uses and preparation."

IV. Prof. Chapman repeated the notice given at the last meeting in reference to alteration of By-Laws.

V. Messrs. Harman, Kingsford and the Secretary were appointed a committee to endeavour to find some more convenient accommodation for the Institute than the rooms at present occupied.

THIRD ORDINARY MEETING.—10*th January*, 1863.

The Rev. J. McCaul, LL.D., President, in the Chair.

The following donations for the Library were announced, and the thanks of the Institute were voted to the donors.

From Prof. J. Hall, Albany, New York:

Fifteenth Annual Report of the University of the State of New York on the Cabinet of Natural History, &c., 1862.

Contributions to Palæontology.

From Hon. J. M. Brodhead, Washington:
Patent Office Reports, 1861, Agriculture. Vol. I.
Preliminary Report, Census, United States, 1860. Vol. I.
Regents' Annual Report Smithsonian Institution, 1861. Vol. I.

From Association for Promotion of Social Science, per Hon. G. W. Allan, M.L.C.
The Transactions of the Association for 1860 and 1861. 2 vols.

From Hon. Sir J. B. Robinson, Bart.
Prof. L. Agassiz Contributions to the Natural History of the United States. Vol. IV.

II. *The following Gentleman was elected a Member*:

W. MORTIMER CLARK, Esq., Toronto.

III. The notice for the alteration of By-Laws given by Prof. Chapman on 13th and 20th December, 1863, was submitted to the meeting and carried.

IV. The President, the Rev. J. McCaul, LL.D., read the Annual Address.

On motion of Mr. Harman, seconded by Mr. Kingsford, the cordial thanks of the Institute were given to the President for his able and interesting address.

V. *The following Papers were then read:*

By the Rev. C. J. S. Bethune, M.A.
"On the nocturnal Lepidoptera found in Canada.

By Prof. J. B. Cherriman, M.A.
"Note on Guldin's Properties of the centre of gravity.

FOURTH ORDINARY MEETING.—17*th January*, 1863.

The Rev. J. McCAUL, LL.D., President, in the Chair.

I. *The following Gentlemen were elected Members:*

L. MCFADEN, Esq., Toronto.
JOHN WISE MARTIN, Esq., LL.D., T.C.D., Toronto.
JAMES HUBBARD, Esq., Toronto.
CHARLES A. MORSE, Esq., Toronto.
B. F. FITCH, Esq., M.A., Toronto.

II. Moved by Mr. Kingsford, seconded by Doctor Campbell. That the Institute sympathizing with the loss of Professor Chapman at the fire at the Rossin House of his books, and recognizing the literary assistance which for past years he has extended to the Institute, request Prof. Chapman to receive bound vols. of the Journal published to this date, as some slight acknowledgment of the services he has rendered.—Carried.

III. *The following Papers were then read:*

By Prof. D. Wilson, LL.D.
"On the characteristics of the flint implements of the drift as compared with those of a later stone period."

By John Martin, Esq., LL.D.
"On some General Properties of Curves."

FIFTH ORDINARY MEETING.—*24th January*, 1863.

The Rev. J. McCaul, LL.D., President, in the Chair.

I. *The following Papers were read:*

By Mr. A. E. Williamson.
"A proposed classification of the Genus Helix."
By Professor J. B. Cherriman, M.A.
"On Poinsot's memoir on Rotation."
"Remarks on Comets."

SIXTH ORDINARY MEETING.—*31st January*, 1863.

I. *The following donation for the Library was announced, and the thanks of the Institute voted to the donor.*

From W. Kingsford Esq. "Impressions of the West and South during a six weeks holiday."

II. The following resolution recommended by the Council was submitted to the meeting:

The Council and members of the Canadian Institute desire to record their profound sentiments of regret at the lamented death of Sir John Beverly Robinson, Bart.: and to give expression to their grateful recollections of the services rendered by him to this Institute, while he filled the office of President, and of the substantial evidences of his interest in its progress furnished by his valuable gifts to the Library, and to the building fund. The association with this Institute of the name of one so justly esteemed among those who have been foremost in advancing the highest interests of the Province, will ever be felt to add a lustre to its early annals, and confer an additional honor on those who may hereafter fill the chair which he occupied as its president; and the members desire now to record their deep sympathy with the relatives of the deceased on whom the loss of one characterized by virtues so calculated to endear him to all who knew him must be felt as so irreparable a bereavement.

That this resolution be entered on the minutes, that a copy of it be communicated to Lady Robinson; and that the Institute do now adjourn without proceeding to any other business.

SEVENTH ORDINARY MEETING.—*7th February*, 1863.

The President, the Rev. J. McCaul, LL.D., in the Chair.

I. *The following Papers were read:*

By Prof. G. T. Kingston, M.A.
"The Meteorological Report of 1861."
By James Hubbard, Esq.
"On the Fungi."
By B. R. Morris, M.D.
"On the natural checks to the destruction of our crops by insects."

EIGHTH ORDINARY MEETING.—14*th February*, 1863.

Doctor DANIEL WILSON in the Chair.

I. Mr. Harman on behalf of the Committee appointed at the Annual Meeting to endeavour to find some more convenient accommodation for the Institute than those now occupied, reported that the committee had examined the new building in course of erection for the Bank of Toronto, and found that rooms there at present in an unfinished state could be secured on reasonable terms, for the use of the Institute, and recommended that steps be taken to secure them. The report was adopted and the committee discharged.

II. *The following Papers were then read:*

By Prof. G. T. Kingston, M.A.
"On the disturbance of Magnetical Declination at Toronto, during the years 1855–62 inclusive."

Doctor Wilson made a communication relative to a new kind of Cannon which was described to him on his recent visit to Washington.

NINTH ORDINARY MEETING.—21*st February*, 1863.

The President, the Rev. J. McCAUL, LL.D., in the Chair.

I. *The following Papers were read:*

By Doctor W. Ogden.
"On Chloroform and its effects."

A Paper by T. J. Cottle, Esq.,
"On a new species of Astacus," was laid on the table.

TENTH ORDINARY MEETING.—28*th February*, 1863.

The President, the Rev. J. McCAUL, LL.D., in the Chair.

I. *The following donations were announced, and the thanks of the Institute voted to the donors.*

For the Library, from the Societies:

1. Proceedings of the Literary and Philosophical Society of Liverpool, 51st Session, 1861–62.
2. Transactions of the Royal Irish Academy, Vol. XXIV. Part II. Science.

For the Museum from SANDFORD FLEMING, ESQ., C.E.

1. Large Salmon Trout from Lake Huron.

II. *The following Paper was read:*

By S. Fleming, Esq., C.E.
"On the present condition of the oil springs of Enniskillen."

The Rev. Prof. Hincks' Paper—

"Notes on the position and relations of certain families of Birds," was laid on the table.

Mr. Saunders' Paper—

"Catalogue of plants found near London, C. W.," was also laid on the table.

ELEVENTH ORDINARY MEETING.—*7th March*, 1863.

In the absence of the President and Vice Presidents, Professor J. B. CHERRIMAN, M.A., was called to the Chair.

I. *The following Gentlemen were elected Members.*

JOHN L. LIZARS, M.R.C.S., Edinburgh, Toronto.
WILLIAM CLARKE, M.D., Toronto.
JAMES J. O'DEA, M.D., Toronto.
ROBERT EMERY, M.D., Toronto.
JAMES ROWELL, M.D., Toronto.
WILLIAM WINSLOW OGDEN, M.B., Toronto.

II. The Secretary on behalf of the Council gave notice that a special general meeting of the members of the Institute would take place on Saturday the 14th day of March inst., for the purpose of taking into consideration the following resolutions which were recommended for adoption by the Council, viz :

1. That the Canadian Institute sanction the formation of a section, limited to members of the Institute, for the cultivation of Medical Science.

2. That the medical section shall have the management of its own affairs, the election of its officers, &c, and shall report the same to the council, but that its action shall be subject to such regulations and bye laws of the Institute as now exist or may hereafter be enacted.

3. That the Institute shall furnish the Medical Section with the necessary minute books and stationery.

4. That the medical section shall have the privilege of meeting in the rooms of the Institute at any time that may be approved of by the Council.

III. *The following Papers were read:*

By Doctor Daniel Wilson.

"Notes of a recent visit to the Mortonian Collection of the Academy of Natural Sciences of Philadelphia."

By Professor G. T. Kingston, M.A.

"Note on the temperature co-efficients of magnets."

TWELFTH ORDINARY MEETING.—*14th March*, 1863.

SESSION—1862-63.

The President the REV. J. MCCAUL, LL.D., in the Chair.

I. *The following Gentlemen were elected Members:*

MICHAEL LAWLOR, M.D., Toronto.
WM. THOS. AIKEN, M.D., Toronto.
DOCTOR JOSEPH HOWSON, Toronto.

II. *The following donation for the Library was announced.*

Britanno-Roman Inscriptions, by Doctor McCaul, presented by the author.

III. *The following Paper was read:*

By Professor Hind, M.A.
"On the Masquapees."

IV. The President having read the resolutions respecting the proposed medical section, proceeded to put the resolutions clause by clause.

The first clause was put and carried.

The second clause having been read and Doctor Campbell having given notice of his intention to introduce an amendment, the President declared the discussion adjourned to another evening.

The President gave notice that a special general meeting of the Institute would be held on Saturday the 21st inst., at 8 o'clock for the purpose of considering the propriety of erecting a building for the purposes of the Institute.

THIRTEENTH ORDINARY MEETING.—*21st March*, 1863.

SESSION—1862-63.

REV. J. MCCAUL, LL.D., President in the Chair.

I. *The following Gentleman was elected a Member:*

MICHAEL BARRETT, M.A., M.D.

II. The President mentioned to the meeting that the Council had purchased a site for a Building at the corner of Richmond and Clare streets 88 feet in front by 103 feet in depth and that a plan for a building had been prepared and was now submitted. The President also explained the views of the council upon the subject.

Mr. Spreull moved, seconded by Mr. English, that the action of the Council in purchasing the building site be approved and confirmed, which was carried.

Mr. Kingsford moved, seconded by Prof. Chapman, that the council be and are hereby empowered to enter into contracts for the building according to such plans as they may deem expedient. Carried.

The President announced that the plans and estimates for the erection of the building would remain on the table for one week from this date for the inspection of members that suggestions may be made to the council in reference to them.

III. The discussion in reference to the establishment of a medical section in connection with the Institute was resumed.

The second resolution was brought forward.

Mr. Kingsford moved in amendment, seconded by Prof. Chapman,—That the words " that the medical section shall have the management of its own affairs, the election of officers, &c., and shall report the same to the council, but that its action," be omitted Lost.

The second resolution was put and lost.

The third and fourth resolutions were put and carried.

Adjourned on motion of Mr. Freeland, seconded by Professor Cherriman.

FOURTEENTH ORDINARY MEETING.—28*th March*, 1863.

REV. J. MCCAUL, LL.D., President in the Chair.

I. *The following donation for the Library was announced.*

FROM SAMUEL SPREULL ESQ., TORONTO.

On ribs and transverse processes with special relation to the theory of vertebrate skeleton.

On the Relations of the vomer, ethnoid and intermaxillary bones.

II. *The Auditors for the year were appointed.*

GEORGE WILSON ESQ., by the President.

SAMUEL SPREULL, ESQ., by the Meeting.

III. *The followiug Papers were read :*

By P. Freeland Esq.

" On the measurement of microscopic objects."

By the President.

" On the derivation of ancient Roman dates."

By Doctor Bovell.

" On growth and repair."

The President announced that the session would be continued for two more meetings.

FIFTEENTH ORDINARY MEETING.—11*th April*, 1863.

REV. J. MCCAUL, LL.D., President, in the Chair.

I. *The following Gentleman was elected as Junior Member.*

SAMUEL RIDOUT ESQ., Toronto.

II. *The following donation was presented by S. Fleming on behalf of T. Devine, Esq., Crown Land Department, U. C.*

Thirteen electrotype casts of Fossils—the thanks of the Institute were unanimously voted to the donor on motion of Dr. Scadding seconded by P. Freeland Esq.

III. *The following Paper was read:*

By Prof. Chapman Ph. Dr.

"On a specimen of Carbonaceous matter from Lake Superior, with remarks on the origin of the Petroleum, as applied more particularly to the oil district of Western Canada, and some new views on the general formation of Coal."

SIXTEENTH ORDINARY MEETING.—18*th April*, 1863.

Rev. J. McCaul, LL.D., President, in the Chair.

I. *The following Papers were read:*

By Rev. H. Scadding, D.D.

"On Phonetic Anomalies observed in some modern forms of ancient proper names."

By Rev. Prof. G. P. Young:

"Formulæ for the cosines and sines of multiple arcs."

By W. Saunders, Esq, London C. W.

"On Canadian Arctiadæ."

SEVENTEENTH ORDINARY MEETING.—25*th April*, 1863.

T. C. Keefer, Esq., C.E., Vice-President, in the Chair.

I. *The following Gentleman was elected a Member of the Institute.*

Henry J. Clarke, Esq., of Toronto.

II. *The following Paper was read:*

By Sandford Fleming Esq., C.E.:

"Notes on projected Canadian canals to connect the upper Lakes with the St. Lawrence.

Moved by Dr. Thorburn and seconded by Dr. Hall. That the Secretary be requested to transmit a copy of Mr. Fleming's paper of this evening to T. C. Street Esq., M.P.P., for the County of Welland, and to John Simpson Esq., M.P.P., for Town and Township of Niagara.

MONTHLY METEOROLOGICAL REGISTER, AT THE PROVINCIAL MAGNETICAL OBSERVATORY, TORONTO, CANADA WEST,—AUGUST, 1863.

Latitude—43 deg. 39.4 min. North. Longitude—5 h. 17 m. 33 s. West. Elevation above Lake Ontario, 108 feet.

Day.	Barom. at temp. of 32°.				Temp. of the Air.				Excess of mean above Normal.	Tens. of Vapour.				Humidity of Air.				Direction of Wind.			Resul't. Direction.	Velocity of Wind.					Rain in inches.	Snow in inches.
	6 A.M.	2 P.M.	10 P.M.	Mean.	6 A.M	2 P.M	10 PM	ME'N		6 A.M	2 P.M.	10 P.M.	M'N	6 A.M	2 P.M.	10 P.M.	M'N	6 A. M.	2 P. M.	10 P. M.		6 AM.	2 PM.	10 P.M.	Resul't.	ME'N		
1	29.505	29.505	29.530	29.5128	69.5	78.9	72.4	74.55	+ 7.58	.617	.773	.682	.716	.86	.78	.86	.83	w b s	s w b s	s w b w	s 32 w	1.2	12.6	0.5	5.14	5.20	...	...
2	.581	.583	—	—	71 7	85.0	—	—	—	.691	.828	—	—	.89	.69	—	—	Calm.	s w b s	s w b w	s 62 w	0.0	10.5	1.5	5.27	8.41		...
3	.787	.786	.807	.7995	65.9	77.1	66.3	69.58	+ 2.73	.411	.529	.379	.431	.64	.57	.59	.59	N N W	s b E	N	N 16 W	10.5	5.2	8.0	2.68	4.27	...	...
4	.851	.763	.654	.7460	60.1	76.4	68.8	69.17	+ 2.37	.366	.568	.501	.487	.70	.62	.72	.67	N	s E b s	E b N	s 78 E	0.5	5.5	1.0	2.21	2.36	...	...
5	.613	.514	.516	.5485	67.7	83.2	71.7	74.93	+ 8.13	.585	.750	.710	.687	.87	.66	.91	.80	E b N	s s w	N W b N	s 63 W	0.5	11.6	6.0	3.70	6.58	0.075	...
6	.627	.663	.707	.6650	67.0	81.1	65.9	71.50	+ 4.73	.566	.421	.425	.468	.85	.39	.66	.63	N w	N W b w	N N W	N 33 W	0.5	10.0	3.0	4.86	5.16	...	...
7	.688	.608	.557	.6000	61.9	73.5	65.2	68.20	+ 1.52	.451	.550	.550	.536	.82	.66	.88	.78	N N w	s E b E	N	N 78 E	0.5	0.5	2.0	1.23	1.53	0.700	...
8	.463	.429	.411	.4277	67.4	76.0	73.1	73.67	+ 7.00	.632	.731	.738	.688	.94	.81	.90	.83	N E b E	s W b s	s w b s	s 63 w	2.2	6.0	2.5	2.67	4.18	...	...
9	.446	.445	—	—	68.1	78.9	—	—	—	.579	.740	—	—	.85	.75	—	—	Calm.	s W	Calm.	s 31 W	0.0	5.5	0.0	1.62	1.81	0.055	...
10	.592	.604	.566	.5827	69.5	80.3	72.4	74.70	+ 8.18	.661	.737	.666	.693	.92	.71	.84	.81	Calm.	s	E s E	s 21 E	0.0	2.0	1.5	1.12	1.46	0.023	...
11	.490	.352	.556	.4698	73.5	82.9	67.0	74.38	+ 7.95	.733	.770	.512	.655	.89	.68	.77	.76	s s W	s W b s	w s w	s 51 W	5.5	19.0	0.8	7 32	9.09	...	...
12	.751	.789	.809	.7882	56.9	70.2	60.5	62.78	— 3.55	.374	.443	.432	.412	.80	.60	.81	.72	N w b w	s w b s	Calm.	N 88 w	0.5	10.0	0.0	2.03	3.75	...	...
13	.830	.785	.689	.7603	53.3	72.8	67.4	65.92	— 0.32	.366	.435	.534	.467	.90	.54	.80	.74	Calm.	s E b E	E b N	N 71 E	0.0	3.5	1.2	0.76	2.21	...	...
14	.853	.604	.663	.6380	64.1	82.5	71.7	73.18	+ 6.95	.524	.566	.661	.590	.87	.51	.86	.74	Calm.	W b N	N w	s 84 W	0.0	10.8	1.5	2.17	4.45	...	...
15	.742	.744	.723	.7342	63.7	72.0	66.6	67.42	+ 1.27	.554	.584	.586	.572	.93	.75	.90	.85	N N W	E b N	Calm.	N 77 E	4.6	2.5	0.0	1.59	2.06	Inp.	...
16	.655	.610	—	—	67.4	72.8	—	—	—	.534	.680	—	—	.80	.85	—	—	E	s b E	N E	N 43 E	2.6	1.8	6.0	4.11	4.85	0.080	..
17	.857	.898	.922	.8950	55.1	67.0	54.7	59 53	— 6.43	.353	.355	.358	.354	.82	.53	.84	.71	N	S	Calm.	s 74 E	5.8	4.2	0.0	1.49	3.14	...	..
18	.935	.891	.784	.8667	53.3	68.4	58.7	61.05	— 4.78	.341	.455	.396	.405	.84	.65	.80	.75	Calm.	s s E	Calm.	s 13 W	0.0	4.5	0.0	0.88	1.39	...	...
19	.761	.604	.604	.6465	55.4	86.1	68.1	71.92	+ 6.15	.360	.728	.608	.580	.82	.58	.88	.74	N W b N	W	Calm.	N 88 W	1.2	12.5	0.0	2.79	4.70	0.050	...
20	.606	.569	.557	.5757	68.4	65.5	63.0	65.22	— 0.33	.618	.586	.539	.575	.89	.93	.93	.92	N	E b N	N E b N	N 54 E	6.8	6.5	1.5	1.95	2.25	0.805	...
21	.613	.591	.517	.5623	63.4	73.5	67.3	68.72	+ 3.28	.541	.594	.619	.571	.92	.72	.92	.82	Calm.	s b w	s W b s	s 24 w	0.0	1.5	4.2	2.16	2.46	...	...
22	.438	.410	.553	.4708	67.4	77.8	60.1	67.87	+ 2.53	.617	.573	.439	531	.92	.60	.84	.78	s W b s	W b s	N N W	N 63 W	4.5	11.2	7.2	5.01	7.04	0.030	...
23	.658	.673	—	—	53.1	64.8	—	—	—	.315	.338	—	—	.77	.55	—	—	N	E S E	s E	S 54 E	5.7	4.4	12.0	3.85	4.37	0.005	...
24	.402	.340	.677	.4865	67.0	78.2	56.9	67.72	+ 2.77	.623	.686	.319	.563	.93	.71	.68	.79	s E b s	s W b W	w N W	s 87 w	2.0	16.8	5.0	7.64	11.54	0.005	...
25	.777	.767	.779	.7803	51.5	65.9	55.1	57.08	— 7.65	.314	.347	.283	.309	.83	.54	.64	.67	N b w	s w b s	N	N 32 W	4.5	6.5	8.0	1.65	5.66	...	...
26	.828	.782	.766	.7913	46.1	65.2	57.2	56.90	— 7.63	.243	.333	.358	.311	.78	.53	.76	.67	N N w	s b w	w b s	s 43 W	1.5	11.6	4.5	3.21	5.38	...	...
27	.719	.620	.546	.6188	53.6	72.0	58.0	62.72	— 1.60	.373	.500	.435	.449	.91	.63	.90	.79	w b s	s s W	Calm.	s 24 w	1.0	13.0	0.0	7.80	7.96	...	...
28	.422	.350	.350	.3663	61.9	71.0	60.5	61.53	+ 0.40	.489	.500	.496	.492	.88	.66	.94	.82	s s W	s b W	s W b s	s 21 W	9.5	15.4	9.0	7.85	8.56	0.380	...
29	.351	.465	.689	.5188	58.0	57.2	46.8	54.12	— 9.70	.441	.250	.253	.304	.92	.53	.79	.72	s W bw	W	W b s	s 78 W	1.7	13.0	6.6	9.65	9.73	...	...
30	.845	.943	—	—	43.9	59.8	—	—	—	.235	.290	—	—	.82	.56	—	—	W b N	s b W	s b W	N 87 W	7.8	9.2	0.5	3.39	5.48	...	...
31	.989	.927	.883	.9252	44.6	60.9	51.8	53.75	— 9.57	.264	.320	.363	.316	.90	.59	.94	.77	s b w	s E b s	E N E	s 79 E	2.5	5.8	4.5	2.69	4.51	...	...
M	29.6650	29.6292	29.6467	29.6453	61.01	73.68	63.35	66.58	+ 0.82	.478	.542	.494	.506	.86	.63	.82	.76	....	....	....	....	2.70	8.16	3.18	......	4.89	2.208	......

REMARKS ON TORONTO METEOROLOGICAL REGISTER FOR AUGUST, 1863.

Highest Barometer . . . . 29.989 at 6 a.m. on 31st. } Monthly range=
Lowest Barometer . . . . 29.321 at 4 p.m. on 28th. } 0.668 inches.

Self-registering Ther.
Maximum temperature . . . 88°0 on p.m. of 19th } Monthly range=
Minimum temperature . . . . 42°4 on a.m. of 31st } 45°6
Mean maximum temperature . . 75°72 } Mean daily range=17°74
Mean minimum temperature . . 57°98 }
Greatest daily range . . . . . . 35°5 from a. m. to p. m. of 19th.
Least daily range . . . . 4°5 from a. m. to p. m. of 20th.

Warmest day . . . 5th...Mean Temperature . . . 74°93 } Difference=21°18.
Coldest day . . . . 31st...Mean Temperature . . . 53°75 }
Maximum Radiation { Solar . . . . 104°0 on p.m of 19th } Monthly range=
Maximum Radiation { Terrestrial . . . . 34°4 on a. m. of 26th } 69°.6

Aurora observed on 5 nights, viz., 5th, 6th, 13th, 15th, and 17th. Possible to see Aurora on 19 nights; impossible on 12 nights.

Raining on 12 days; depth, 2.208 inches; duration of fall, 41.2 hours.

Mean of cloudiness=0.45. Most cloudy hour observed, 4 p.m; mean=0.54; least cloudy hour observed, 8 a.m.; mean=0.35.

Sums of the components of the Atmospheric Current, expressed in Miles.

North.	South.	East.	West.
940.71	1589.94	482.53	1652.78

Resultant direction, S. 61° W.; Resultant Velocity, 1.80 miles per hour.
Mean velocity 4.89 miles per hour.
Maximum velocity 24.0 miles, from 5 to 6 p.m. on 11th and 24th.
Most windy day 24th—Mean velocity 11.54 miles per hour. } Difference 10.15.
Least windy day 18th—Mean velocity 1.39 miles per hour. }
Most windy hour, 1 to 2 p.m.—Mean velocity, 8.56 miles per hour. } Difference
Least windy hour, 4 to 5 a.m.—Mean velocity, 2.21 miles per hour. } 6.35 miles.

2nd. Thunder and lightning in N.W. 4 to 8 p.m.; rainbow at 6 p.m.—5th. Thunderstorm 4 to 6 p.m.; rainbow 6 to 7 p.m.—9th. Rainbow 3.30 to 4 p.m.—10th. Sheet lightning, accompanied by rain at 10 p.m.—15th. Distant thunder and light rain 9 to 10 a.m.—16th. Distant thunder at 6 a.m.—20th. Distant thunder in N.W. at 6 a.m.—22nd. Thunderstorm 9 to 10 a.m.—23rd. Thunderstorm 8 to 9 p.m.—24th. Distant thunder and slight rain 2 to 4 p.m.—26th. Hoar frost at 6 a.m., (first of season).—27th. Lunar halo at midnight.—29th. Thunderstorm 4.30 to 6.30 p.m.

Heavy dew recorded on 14 mornings during this month.
Sheet lightning, alone, observed on 7 evenings during the month.
Great change of temperature from a.m. to p.m. of 19th. Range=35°5 in 15 hours.

August, 1863, was comparatively mild, dry, and calm, and the amount of clouds equalled the average.

COMPARATIVE TABLE FOR AUGUST.

YEAR.	TEMPERATURE.					RAIN.		SNOW.		WIND.		
	Mean.	Excess above Average, (66°0).	Maximum observed.	Minimum observed.	Range.	No. of days.	Inches.	No. of days.	Inches.	Resultant. Direction.	Resultant. Velocity.	Mean Force or Velocity
1840	° 64.7	— 1.3	° 80.1	° 47.4	° 32.7	12	2.905	...	...	...	...	...
1841	64.4	— 1.6	83.5	46.7	36.8	9	6.170	...	...	...	...	0.19 lbs
1842	65.7	— 0.3	80.7	45.3	35.4	6	2.500	...	...	...	...	0.30 “
1843	66.4	+ 0.4	85.5	44.4	41.1	4	4.850	...	...	...	...	0.12 “
1844	64.3	— 1.7	82.5	44.3	38.2	17	Imp.	...	...	...	...	0.16 “
1845	67.9	+ 1.9	82.5	44.4	38.1	9	1.725	...	...	...	...	0.19 “
1846	68.4	+ 2.4	86.3	50.4	35.9	9	1.770	...	...	...	...	0.17 “
1847	65.1	— 0.9	83.1	44.9	38.2	10	2.140	...	...	...	...	0.19 “
1848	69.2	+ 3.2	87.5	49.3	38.2	8	0.855	...	...	S 21 E	0.98	4.55 ms
1849	66.3	+ 0.3	79.5	51.4	28.1	10	4.970	...	...	N 71 W	0.60	3.76 “
1850	66.8	+ 0.8	84.2	43.0	41.2	13	4.355	...	...	N 15 E	0.35	4.46 “
1851	63.6	— 2.4	79.8	43.6	36.2	10	1.360	...	...	N 63 W	0.40	4.63 “
1852	65.9	— 0.1	81.2	46.7	34.5	9	2.695	...	...	N 70 E	0.56	3.30 “
1853	68.6	+ 2.6	91.6	47.6	44.0	11	2.575	...	...	S 36 E	0.30	4.26 “
1854	68.0	+ 2.0	98.1	47.0	51.1	5	0.455	...	...	N 64 W	1.76	4.60 “
1855	64.1	— 1.9	82.1	44.9	37.2	7	1.455	...	...	N 63 W	1.04	6.97 “
1856	63.6	— 2.4	81.3	44.0	37.3	12	1.680	...	...	N 50 W	2.88	7.03 “
1857	65.3	— 0.7	85.3	50.1	35.2	13	5.265	...	...	N 77 W	1.51	6.36 “
1858	67.6	+ 1.6	83.4	45.4	38.0	11	3.890	...	...	N 69 W	1.57	6.50 “
1859	66.6	+ 0.6	81.4	46.2	35.2	11	3.990	...	...	N 36 W	1.62	5.96 “
1860	64.5	— 1.5	81.8	47.1	34.7	14	3.405	...	...	N 70 W	1.83	5.80 “
1861	65.5	— 0.5	82.5	48.2	34.3	15	2.953	...	...	N 8 E	0.46	4.21 “
1862	67.6	+ 1.6	87.6	47.7	39.9	15	3.483	...	...	N 78 W	1.67	5.96 “
1863	66.6	+ 0.6	87.2	43.9	43.3	12	2.208	...	...	S 61 W	1.80	4.89 “
Results to 1861.	66.02	...	83.81	46.47	37.35	10.2	2.951	...	...	N 58 W	0.85	5.17
Exc. for 1863.	+0.56	...	+ 3.39	— 2.57	+ 5.95	+ 1.8	— 0.743	...	...	...	...	— 0.28

MONTHLY METEOROLOGICAL REGISTER, AT THE PROVINCIAL MAGNETICAL OBSERVATORY, TORONTO, CANADA WEST,—SEPTEMBER, 1863.

Latitude—43 deg. 39.4 min. North. Longitude—5 h. 17 min. 33 sec. West. Elevation above Lake Ontario, 108 feet.

Day.	Barom. at temp. of 32°.				Temp. of the Air.				Excess of mean above Normal.	Tens. of Vapour.				Humidity of Air.				Direction of Wind.			Resultant Direction.	Velocity of Wind.					Rain in Inches.	Snow in Inches.
	6 A.M.	2 P.M.	10 P.M.	MEAN.	6 A.M	2 P.M.	10 PM	ME'N		6 A.M	2 P.M.	10 P.M.	M'N	6 A.M	2 P.M.	10 P.M.	M'N	6 A.M.	2 P.M.	10 P.M.		6 A.M	2 P.M	10 PM	Re-sul't.	ME'N		
1	29.874	29.795	29.749	29.8005	51.1°	68.1°	55.4°	58.45°	— 4.58°	.352	.369	.394	.370	.94	.53	.89	.76	N N E	S S W	S E b E	S 16° E	2.8	4.5	2.5	1.34	2.38	...	...
2	.709	.678	.632	.6757	52.2	68.4	60.5	60.75	— 1.98	.369	.455	.419	.417	.94	.65	.80	.78	S E	S E	N	N 17 E	0.8	1.0	15.0	4.99	7.64	...	...
3	.736	.740	.813	.7647	51.8	61.2	50.8	54.53	— 7.88	.270	.239	.262	.252	.70	.44	.70	.60	N	N b W	N b W	N 1 W	13.8	12.8	13.5	10.97	11.12	...	...
4	.833	.804	.739	.7900	45.0	59.1	48.6	51.60	—10.53	.221	.256	.241	.237	.74	.51	.69	.62	N	S b E	N E b N	S 85 E	8.0	8.4	6.4	2.56	5.97	...	...
5	.700	.585	.573	.6143	46.1	64.5	59.4	58.05	— 3.78	.234	.442	.434	.375	.75	.73	.86	.76	N N E	E b N	N b W	N 78 E	4.2	7.8	1.5	2.88	3.72	...	...
6	.633	.671	—	—	58.0	69.2	—	—	—	.428	.443	—	—	.89	.62	—	—	N b W	N b W	N N W	N 11 W	0.5	2.0	8.0	5.48	5.60	Inp.	...
7	.826	.785	.741	.7822	54.4	62.1	59.4	59.40	— 1.75	.373	.449	.375	.410	.88	.81	.74	.81	N N E	E b S	E b S	N 86 E	5.6	5.2	2.0	3.39	3.99	...	...
8	.651	.638	.809	.7093	57.6	70.6	55.8	61.98	+ 1.25	.458	.603	.322	.463	.96	.81	.72	.81	S E b E	W N W	N N W	N 38 W	1.5	14.2	5.3	7.39	9.97	Inp.	...
9	.954	.945	.972	.9573	45.4	58.0	48.6	51.25	— 9.10	.225	.228	.241	.238	.74	.47	.69	.64	N N E	S b E	N	N 57 E	7.0	5.8	8.5	3.29	6.21	...	...
10	30.013	.939	.811	.9087	44.3	60.5	55.1	54.92	— 5.13	.221	.292	.386	.309	.76	.54	.89	.72	N b E	E	E b N	S 84 E	6.0	8.2	2.3	4.30	4.73	...	...
11	29.731	.611	.599	.6335	57.6	67.4	63.0	63.45	+ 3.80	.434	.561	.487	.508	.92	.83	.85	.87	E N E	S W b S	S W b W	S 55 W	0.6	5.0	1.8	3.28	4.96	0.215	...
12	.584	.636	.677	.6397	59.8	63.4	55.4	60.13	+ 0.90	.465	.417	.349	.406	.90	.71	.80	.78	N W b N	N	N b E	N	1.2	10.0	7.2	6.47	7.30	Inp.	...
13	.713	.701	—	—	49.7	60.9	—	—	—	.298	.321	—	—	.83	.59	—	—	N E b N	S E	S E b E	S 85 E	6.2	3.0	4.5	3.94	4.40	...	...
14	.743	.728	.735	.7392	51.8	71.3	61.9	62.07	+ 3.73	353	.509	.428	.433	.92	.66	.77	.78	S E b E	S b W	S W b S	S 24 W	0.8	9.8	3.0	5.08	5.22	...	...
15	.773	.708	.723	.7333	60.9	78.2	63.0	67.55	+ 9.63	.503	.559	.450	.503	.94	.58	.78	.76	S W	S W b S	Calm.	S 35 W	7.5	15.2	0.0	6.39	6.42	...	...
16	.735	.663	.571	.6502	58.0	76.0	64.8	67.90	+10.38	.452	.604	.542	.562	.94	.67	.88	.83	S W b W	S E	S b E	S 20 E	1.0	8.5	0.8	3.43	3.71	...	...
17	.541	.390	.271	.3883	65.9	78.2	67.7	70.43	+13.43	.567	.604	.585	.590	.89	.63	.87	.80	S b W	S b W	W b S	S 19 W	4.2	13.0	8.2	6.98	9.04	0.770	...
18	.261	.319	.490	.3627	54.7	50.4	44.6	48.75	— 7.87	.370	.227	.217	.268	.86	.61	.74	.76	N N W	N W	W b N	N 44 W	17.2	24.5	7.0	12.82	13.25	.195	...
19	.571	.600	.657	.6140	36.5	50.4	41.4	43.82	—12.30	.199	.255	.214	.219	.92	.69	.81	.76	W N W	S b W	N W b W	S 83 W	3.5	8.0	3.0	4.39	6.08	...	...
20	.712	.678	—	—	38.9	54.7	—	—	—	.176	.242	—	—	.76	.56	—	—	W b N	S W	S W b W	S 60 W	1.8	7.0	5.0	4.76	4.98	0.055	...
21	.595	.643	.900	.7298	51.8	56.9	42.1	49.87	— 5.25	.333	.286	.178	.260	.86	.62	.66	.71	S W b W	N W b N	N W b N	N 48 W	4.8	21.0	6.8	9.51	10.37	...	...
22	30.062	30.114	30.111	30.0967	37.8	51.8	45.7	45.82	— 8.82	.165	.186	.231	.196	.72	.48	.75	.64	N N W	S S E	S b W	S 5 W	3.0	9.7	3.8	3.23	7.08	...	...
23	30.040	29.899	29.823	29.9082	48.6	61.2	54.0	55.08	+ 0.87	.282	.339	.325	.315	.82	.63	.78	.73	S b E	S	S	S 1 E	7.5	10.0	1.2	6.04	6.12	...	...
24	29.664	.655	.779	.7078	55.8	58.3	44.6	52.00	— 1.75	.401	.391	.226	.325	.90	.80	.77	.81	S by W	N b W	N	N 16 W	4.2	12.2	10.4	9.40	10.17	Inp.	...
25	.844	.849	.887	.8630	41.4	47.1	38.5	42.58	—10.65	.214	.181	.173	.196	.81	.56	.74	.71	N b W	N	N N W	N 9 W	10.5	10.8	9.0	10.26	10.55	...	...
26	.872	.799	.771	.8122	34.5	50.4	39.2	41.80	—10.93	.148	.197	.180	.173	.75	.53	.75	.65	N	S	S S W	N 55 W	8.0	9.0	5.0	0.67	5.30	...	...
27	.785	.720	—	—	31.6	56.9	—	—	—	.156	.286	—	—	.87	.61	—	—	N	S	Calm.	S 9 E	2.8	3.8	0.0	1.86	2.38	...	...
28	.702	.676	.684	.6878	47.5	61.2	52.9	54.18	+ 2.35	.316	.398	.327	.344	.96	.73	.82	.82	S E	E b S	N E	N 75 E	2.0	7.8	5.0	3.60	4.62	..	...
29	.733	.745	.766	.7470	52.2	63.0	56.5	57.55	+ 6.23	.327	.450	.335	.373	.83	.78	.73	.78	N E b N	E S E	N E b E	N 63 E	4.5	5.3	1.2	3.51	4.29	...	...
30	.758	.737	.695	.7273	52.2	65.2	58.7	58.93	+ 8.12	.327	.393	.361	.367	.83	.63	.73	.74	N N E	E S E	N E b E	N 66 E	4.3	5.0	8.0	5.86	6.22	...	...
31	......	......	......	....	......	......	......	....	....	......	......	......	......	....	....	....	....	....	....	....	....	......	......	......	....	....	....	...
M	29.7504	29.7185	29.7299	29.7324	50.57	62.42	53.37	55.88	— 1.61	.330	.381	.334	.350	.85	.64	.78	.75	....	....	....	....	4.86	8.95	5.20	....	6.46	1.235	......

REMARKS ON TORONTO METEOROLOGICAL REGISTER FOR SEPTEMBER, 1863.

Highest Barometer..........................30.140 at 10 a.m. on 22nd } Monthly range =
Lowest Barometer ....29.259 at 8 a. m. on 18th } 0.881 inches.

Self-registering Thermom. { Maximum Temperature .... 80°0 on p.m. of 17th } Monthly range=
Minimum Temperature .... 31°4 on a.m. of 27th } 48°6
Mean maximum Temperature .... 64°49 } Mean daily range=
Mean minimum Temperature .... 46°99 } 17°50
Greatest daily range ...... 27°1 from a.m. to p.m. of 27th.
Least daily range............ 7°0 from a.m. to p.m. of 18th.

Warmest day .... 17th... Mean temperature......... 70°43 } Difference = 28°63.
Coldest day .... 26th... Mean temperature......... 41°80 }
Maximum { Solar...................................... 94°0 on p.m. of 16th } Monthly range =
Radiation. { Terrestrial.............................. 22°6 on a.m. of 27th } 71°4
Aurora observed on 8 nights, viz.,—8th, 9th, 10th, 16th, 18th, 19th, 22nd and 23rd.
Possible to see Aurora on 21 nights; impossible on 9 nights.
Snowing on . days, depth ... inches; duration of fall, ... hours.
Raining on 8 days, depth 1.235 inches; duration of fall 19.0 hours.
Mean of cloudiness = 0.42.
Most cloudy hour observed, 8 a.m: mean = 0.55; least cloudy hour observed, 10 p.m.; mean, = 0.32.

Sums of the components of the Atmospheric Current, expressed in miles.

North.	South.	East.	West.
2255.81	1343.11	974.65	1238.64

Resultant direction N. 16° W.; Resultant velocity 0.92 miles per hour.
Mean velocity ....6.46 miles per hour.
Maximum velocity .... 24.5 miles, from 1.30 to 2.30 p.m. on 18th.
Most windy day ......18th............Mean velocity, 13.25 miles per hour. } Difference=
Least windy days ...1st & 27th....Mean velocity, 2.38 ditto. } 10.87 miles.
Most windy hour .... 2 to 3 p.m...............Mean velocity, 9.40 ditto. } Difference=
Least windy hour ...6 a.m. to 7 a.m.........Mean velocity 4.71 ditto. } 4.69 miles.

1st. Fog at 6 a.m.; and again at 10 p.m., and midnight.—2nd. Ground Fog 6 a.m. Sheet lightning in W & S W at midnight.—5th. Sheet lightning in S W at 10 p.m.—7th. Dense fog at 10 p.m. and midnight.—10th. Hoar frost at 6 a.m.—11th. Ground fog at 6 a.m., and sheet lightning in W at 10 p.m. and midnight.—14th. Sheet lightning in N E from 8 p.m.—16th. Dense ground fog at 6 a.m.—17th. Thunderstorm from 7 p.m. to midnight.—19th. Sharp hoar frost 6 a.m.—20th. Sharp hoar frost 6 a,m.—22nd. Slight hoar frost 6 a.m.; Slight fog from 6 p.m.; Lunar Halo at 10 p.m. and midnight.—24th. Distant Thunder in S & S W 10 to 11.30 a.m.—26th. Sharp frost and thin ice at 6 a.m., Lunar Corona at midnight.—27th. Thin ice at 6 a.m.—30th. Fog 7.30 to 8 a.m.; Lunar Corona at 10 p.m. and midnight.

September, 1863, was comparatively cold, dry, windy, and clear.

COMPARATIVE TABLE FOR SEPTEMBER.

YEAR.	TEMPERATURE.					RAIN.		SNOW.		WIND.		
	Mean.	Excess above aver'ge (57.9)	Max. ob-served.	Min. ob-served.	Range.	No. of days.	Inches	No. of days.	Inches	Resultant. Direction.	Resultant. V'y.	Mean Force or Velocity.
1840	° 54.0	° — 3.9	° 70.2	° 29.4	° 40.8	4	1.380	...	...	...	...	....
1841	61.3	+ 3.4	79.9	37.5	42.4	9	3.340	...	...	...	...	0.26 lbs.
1842	55.7	— 2.2	83.5	28.3	55.2	12	6.160	...	...	...	...	0.45
1843	59.1	+ 1.2	87.8	33.1	54.7	10	9.760	...	...	...	...	0.57
1844	58.6	+ 0.7	81.5	29.6	51.9	4	Imp.	...	...	...	...	0.26
1845	56.0	— 1.9	78.8	35.3	43.5	16	6.245	...	...	...	...	0.34
1846	63.6	+ 5.7	84.0	39.0	45.0	11	4.595	...	...	...	...	0.33
1847	55.6	— 2.3	74.8	38.1	36.7	15	6.665	...	...	...	...	0.33
1848	54.2	— 3.7	80.9	29.5	51.4	11	3.115	...	...	N 71° W	2.38	5.81mls.
1849	58.2	+ 0.3	80.6	33.5	47.1	9	1.480	...	...	N 75° W	0.69	4.23
1850	56.5	— 1.4	76.0	31.7	44.3	11	1.735	...	...	S 65° W	1.02	4.78
1851	60.0	+ 2.1	86.3	33.4	52.9	9	2.665	...	...	N 14° E	1.03	5.45
1852	57.5	— 0.4	81.8	36.1	45.7	10	3.630	...	...	N 77° W	0.53	4.60
1853	58.8	+ 0.9	85.4	36.1	49.3	12	5.140	...	...	N	1.06	4.33
1854	61.0	+ 3.1	93.1	36.3	56.8	14	5.375	...	...	N 22° W	1.33	4.04
1855	59.5	+ 1.6	81.7	36.1	45.6	12	5.585	...	...	N 20° E	1.29	7.61
1856	57.1	— 0.8	77.3	37.4	39.9	13	4.105	...	...	S 79° W	1.98	6.53
1857	58.6	+ 0.7	81.4	34.1	47.3	11	2.640	...	...	N 68° W	1.61	5.55
1858	59.1	+ 1.2	80.1	36.8	43.3	8	0.735	...	...	S 74° W	1.53	5.69
1859	55.2	— 2.7	73.8	35.7	38.1	15	3.525	...	...	N 44° W	1.60	6.36
1860	55.3	— 2.6	74.2	28.7	45.5	14	1.959	...	...	N 71° W	2.63	5.79
1861	59.1	+ 1.2	78.2	37.1	41.1	17	3.607	...	...	N 71° W	1.39	4.81
1862	59.6	+ 1.7	78.9	41.0	37.9	9	2.344	...	...	N 59° W	1.07	5.11
1863	55.9	— 2.0	78.2	31.6	46.6	8	1.235	...	...	N 16° W	0.92	6.46
Results to 1861.	57.91	...	80.51	34.22	46.30	11.2	3.973	...	...	N 62° W	1.13	5.40
Exc. for 1863.	— 2.03	...	— 2.31	— 2.62	+ 0.30	— 3.2	— 2.738	...	...	....	......	+ 1.06

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